Twentieth Annual Report

OF THE

North Dakota Agricultural Experiment Station

Agricultural College, North Dakota

TO

The Governor of North Dakota

1910

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LETTER OF TRANSMITTAL.

Agricultural College, N. D., February 1st, 1910.

Hon. John Burke, Governor of the State of North Dakota.

Sir: As required by Act of Congress, approved March 2, 1887, I hereby submit the Twentieth Annual Report of the North Dakota Experiment Station for the year ending February 1st, 1910, together with a financial statement of receipts and disbursements, as required by law, for the government of fiscal year ending June 30th, 1909.

Respectfully,

GEORGE H. HOLLISTER,

Pres. of the Board of Trustees, N. D. A. C.

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R. M. DOLVE, B. S., Asst. Agr. (Engineering).
ADELE SHEPPERD, Asst. Chem. (Waters).
O. W. DYNES, B. S., Asst. Agr. (Poultry).
EMILY MAY, M. S., Asst. Chem. (Cereals).
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H. F. BERGMAN, B. S., Asst. Botanist (Mycology).
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G. A. ABBOTT, Ph. D., Asst. Chem. (Paints).
H. P. BASSETT, Ph. D., Asst. Chem. (Beverages).
ORIN A. STEVENS, B. S., Asst. Bot. (Seed Analysis).
E. D. HARRIS, D. V. M., Asst. Vet.
R. C. CLIFF, V. S., Asst. Vet.
GEORGE L. MARTIN, B. S. A., Asst. Agr. (Dairying).
E. B. PUTT, B. S., Asst. Chem. (Beverages).
C. V. KENNEDY, Farm Foreman.
W. A. YODER, Secretary.

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O. A. THOMPSON, B. S. ..... Superintendent
CLARENCE PLATH, B. S. A. ..... Assistant Agriculturist*

DICKINSON SUB-STATION.

L. R. WALDRON, M. S. ..... Superintendent
JOHN THYSELL, B. S. A. ..... Assistant Agriculturist*
CHARLES H. CLARK, B. S. A. ..... Assistant Agriculturist

WILLISTON SUB-STATION.

E. G. SCHOLLANDER, B. S. ..... Superintendent
F. R. BABCOCK, B. S. A. ..... Assistant Agriculturist*
W. O. WHITCOMB, B. S. A. ..... Assistant Agriculturist*
A. M. HAWLEY ..... Assistant Agriculturist*

LANGDON SUB-STATION.

E. D. STEWART, B. S. ..... Superintendent

HETTINGER SUB-STATION.

W. R. LANXON, B. S. A. ..... Superintendent

DEMONSTRATION FARMS.

W. R. PORTER, B. S. ..... Superintendent
M. B. JOHNSON ..... Assistant Superintendent
W. A. YODER ..... Secretary

*Detailed to this sub-station from the U. S. Department of Agriculture for Co-operative Work.

REPORT

To the Board of Trustees of the North Dakota Agricultural College and Experiment Station:

Gentlemen:

I have the honor to submit herewith the 20th Annual Report of the North Dakota Government Experiment Station.

The following bulletins were published during the year:

No. 84.	Fattening Hogs (a) Barley Compared with Corn (b) Low Grade Wheat Compared with Corn	J. H. Shepperd
	(c) Effect of Cross Breeding on Gains Made and Carcasses	W. B. Richards
No. 85.	Glanders	Dr. L. Van Es
No. 86.	Some Ready Mixed Paints	E. F. Ladd
No. 87.	Seed Disinfection and Crop Production Methods and Types of Machinery Needed	H. L. Bolley

VETERINARY BUILDING.

The new veterinary building for which $30,000 was appropriated by the last Legislative Assembly, was completed and ready for occupancy early in January of the present year. Dr. Van Es and his assistants removed into their new quarters about the middle of January and the enlarged facilities afforded by the new laboratories, stables, and lecture rooms will

greatly facilitate the experimental work of the department of veterinary. The veterinary building contains approximately 12,000 square feet of floor space, is built of Hebron pressed brick and is a model of convenience and adaptability for the work of the department.

DAIRY BUILDING.

The dairy interests of the state make it imperative that we erect a suitable plant for instruction and experimentation as soon as the finances of the state will warrant. Under present lack of facilities, instruction in butter-making is offered, during the winter months only, while all lines of experimental work is held in abeyance, pending the erection and equipment of a suitable dairy laboratory, A model dairy barn is also contemplated as well as a selected dairy herd of cattle.

A fine field for experimental feeding for milk production is offered as well as how best to care for dairy cows where the winters are long and severe. Different breeds of dairy cattle should also be tested, both for profitable milk production and adaptation to local climatic conditions.

EXTENSION EXPERIMENTAL WORK.

Demonstration farms are now conducted in twenty-one different counties, all the expense of which is borne by the state. The purpose of these farms is to put into practical operation cultivation methods, crop rotation, application of fertilizers, and use of improved seed grains, etc., according to local conditions and in harmony with results obtained at the several experiment stations. These demonstration farms are operated in a field way, the several fields being uniformly of four acres each and though the chief purpose is to demonstrate the advantages of crop rotation, yet tillage, fertilization, etc., are given much consideration. The results so far obtained are entirely satisfactory and more than justify the comparatively small expenditures of money necessary to operate so many farms distributed as they are so widely throughout the state. It would, doubtless, prove a good investment to establish at least one such demonstration farm in every county. No better argument can be made in favor of improved farm management than to do, even on a comparatively small scale, the things that should be done, and in the way they should be done, to produce the best results.

FIRE LOSS.

The total loss of the Chemical Laboratory by fire on Christmas eve will seriously handicap the work of the chemical department until a new laboratory can be provided. Temporary laboratories have been improvised, however, in the Engineering building, in Science Hall, and in the flouring mill, and the division of Pharmacy has been given the quarters previously occupied by the Department of Veterinary. Though seriously inconvenienced and all departments greatly overcrowded, yet the work in the several divisions of chemistry is given with its usual efficiency. A new and fire proof building should be erected and ready for occupancy by next fall.

INVESTIGATION.

The experimental work for the past year was along lines previously mapped out and will be continued during the coming year. Many interesting problems present themselves from time to time and, as far as means permit, they are given consideration. In the main, however, the investigational work is carried on along lines considered fundamental and directly related to plant and animal diseases, moisture and fertility conservation, crop rotation, breeding and feeding of live stock, destruction of noxious weeds, and effects of tile and open drainage on the College farm, etc.

J. H. WORST, Director.

AGRICULTURAL DEPARTMENT

To Director J. H. Worst:

Sir: The work of the Agricultural Department has not changed in its general scope materially from the plan described in my earlier reports. The work in several of the lines has been expanded as will be shown in the body of this report.

The addition of two more sub-stations and nine demonstration farms to the list has added largely to the time which I have devoted to carrying out your orders in planning and supervising their work.

The trials already reported upon from time to time have brought out a vast number of questions and have made the instruction by correspondence heavy. This instruction is badly needed, however, and is in my opinion well worth the effort and time which it requires.

The Agricultural Department has added George L. Martin, B. S. A., to its regular force and he will take up work under the title assistant in dairying. Mr. C. M. Hennis has resigned as farm foreman, and his place was filled by the election of C. V. Kennedy, who has been in charge of that work for the last ten months.

This Department has taken charge of the enforcement of the stallion registration law in the state and has added Burke Critchfield, B. S. A., to its force to aid in carrying out the details of that work.

The other changes have been minor ones and have been fewer than during any similar period in the history of the Department.

According to statistics supplied by our state auditor, which have been carefully revised by our state equalization board, and also according to the report of the Bureau of Statistics of the United States Department of Agriculture, the amount of live stock, other than horses and mules in the State of North Dakota has gradually decreased during the last half dozen years. This has doubtless resulted largely from the breaking up of the ranches on the open prairies in the western part of our state and the settling up of that land by small

farmers. I fear, however, that the result may not all have come from the breaking up of these ranches. The small farmer, on account of the large number which his class of settlers represent when compared with the ranch settlements, should have enough live stock, if he was rightly equipped to take care of the roughage and rotated crops which he should grow, to offset the loss from the dissolution of the ranches. It seems certain that diversified farming is not making the progress that is desirable, either on account of the high prices paid for grain or from indifference on the part of our land owners. The experience of the station and the experience of our farmers in diversified cropping are all markedly in its favor but there is still great indifference about adopting the plan. In view of these facts, I am following the policy of pushing farm management and rotation studies and of encouraging the production of live stock by aiding fair organizations, live stock breeders' associations, farmers' institute work and all other organized efforts, which will have a tendency to improve our situation in that particular.

The dairy work will now be given considerable attention, although our lack of facilities in the way of a building and apparatus will necessarily limit our investigation work along that line. It is anticipated that the time which will intervene between this date and the time of providing a suitable dairy building and equipment can be well used for getting acquainted with the dairy conditions and the dairy interests of the state. The trial in cost of milk and butter production which has been under way for some time, has been carried without interruption and is adding data of unusual interest and value. More than a year and half of our results include the amount of milk yielded, the total butter fat, the amount of food consumed and its value for each dairy cow in our herd. This data together with a record of the milk yield for a much longer period of time is supplying facts that will prove very vital to dairy interests in this state.

The breeding circuit with Holstein-Friesian cattle, which has been instituted at New Salem, is now carrying two hundred cows and yielding data that will be of unusual interest to dairymen, in addition to giving results in hereditary studies and live stock improvement, which represent the main features of the trial.

The work of the department in live stock feeding has been even more restricted than in previous years by reason of the large school attendance and the number of animals required for class work increasing in very large proportion without any additional housing for animals, aside from poultry, having

been provided. Straw sheds and cold out-buildings, which I attempted to use for this purpose earlier, proved so unsatisfactory that I decided to wait until better facilities are provided before attempting to put on additional work in experimental lines.

The work in farm management or crop rotation has been given large attention during the past year, as the demonstration farms, sub-stations, and central station now furnish me twenty-seven farms at as many different points in the state upon which to record results of field trials in crop rotation. Rotation work on the central station upon the original trial plats has been interrupted for two seasons, while we took the time to clean the land from weeds and prepare it for a continuance of the trial. The original continuous grain producing plot, however, has been seeded each season and is in position to be compared with the other plats upon which the first series of trials have been worked out.

The rotation trials and farm management studies are far reaching in their application and lead up to such live stock questions as the following: Can cattle be successfully prepared for market with corn fodder? Can corn be pastured off by cattle or sheep cheaply enough to be advisable as a practice? What number of cattle will the temporary pasture of a rotated field carry per ten or twenty acre tract? Can field peas be hogged off satisfactorily? How much value has stubble with dwarf essex rape for fattening sheep and hogs? How does barley compare with corn as a fattening ration for sheep and cattle? These with other numerous questions can only be answered by a series of field rotation studies, in addition to feeding and grazing trials with cattle, sheep and hogs.

The breeding of field crops is being enlarged on the central station and carried out on the sub-station in a connected and systematic form. In this work the demonstration farms have proven very helpful and supplemental by giving me a chance to observe the behavior of new types under various conditions in the state and as a means of rapidly and carefully disseminating the seeds of the best sorts produced. The demand for pedigreed seeds and the appreciation of their value is growing steadily so that the good accomplished and the possibilities for the future are greater than I have recorded heretofore. I have increased the work in the breeding of clover and alfalfa very materially, and have all of the sub-stations at work on the problem of alfalfa breeding and alfalfa culture. Several of the men in charge of the demonstration farms have been induced to make small field trials with alfalfa. In a number of cases the owners of demonstration farms and their neighbors have

taken the results of our work seriously and have taken up red clover growing on a rather extensive scale. A number of experiments are under way in the production of clover and alfalfa seed respectively, by means of special culture methods. This station has the credit of having produced an alfalfa which is proving the hardiest in winter resistance of any that the U. S. Department of Agriculture has collected from any part of the alfalfa growing world. The possibilities in seed production of both alfalfa and clover in this state seem to be unusually good, and I feel that we are warranted in undertaking extensive trials along these lines.

I am giving considerable attention to winter wheat and winter rye, among the cereals with which I am experimenting as they have the advantage of spreading the harvest season, making a better distribution of the work, clearing land for early plowing, giving a part of the money crop a different filling season, of keeping down wild oats by having a harvest season, before wild oats are ripe, and of giving a heavier yield of grain than the spring varieties can be expected to do. The successful growing of these winter grains is proving quite a problem, as the cultural methods which will allow them to come through the winter in satisfactory condition and the varieties adapted to the state seem both to be rather special in their character and must be necessarily well adapted to give the grower satisfactory results.

An extensive study in humus production and in moisture conservation is being carried out on the central and substations, and the results which have been secured are very gratifying.

The adding of stable manure is also a feature of great importance and one which is receiving extended study on all of the farms which the station has under control. The results of the sub-stations and demonstration farms are being handed to you under special reports covering the work of each.

The tile drainage trials which are being carried out by the department present many interesting and important points for experiment work. Considerable data has been gathered upon the time that they draw moisture in the spring, the date which the frost is out of the soil over the drains and between the drains, the effect they have on the water table, the rapidity with which they carry water from the various types of heavy soil and the effect on the soil and on the crops produced. A number of systems of drains have been laid out by our Mr. Dolve on neighboring farms in the Red River Valley, so that our studies are not limited to the station grounds.

Poultry work has been given additional facilities and attention during the past year, since its importance as a productive feature in the state exceeds dairy interests, and since the results secured by poultry keepers are far below what they should secure from the expenditure which they make upon their flocks, it seems advisable to study their problems.

The detail of the work has been carried by the men assisting me in conducting the Department. They have worked together harmoniously and have carried out the detail of the work in an efficient and cheerful manner. My thanks are due and hereby tendered to them for this efficient service.

Respectfully submitted,

J. H. SHEPPERD,
Agriculturist and Vice Director.

CHEMICAL DEPARTMENT

To J. H. Worst, Director:

Sir: I herewith present my Twentieth Annual Report as Chemist of the North Dakota Government Agricultural Experiment Station for the calendar year, 1909.

The work of the Chemical Department, during the past year, has covered a wide range of subjects not only in lines of research work, but since it has been made the duty of the Department to see that the several laws relating to foods, drugs, stock foods, fertilizers, formaldehydes, paris green, paints, beverages and the Sanitary Inspection Law are properly enforced, much additional work is required.

Two lines of agricultural subjects have been under investigation during the past year. A study of the soils has been continued with special reference to the composition of the soils as found upon the various demonstration farms, also, types of soil gathered from other parts of the state. The second line of investigation has been a study of wheat, its milling properties, the chemical composition of the flour, and the baking qualities of the same. For this purpose there have been equipped laboratories especially designed for the work in the mill building. A special study has been made of the chemical composition and relation of the gliadin and gluten contents to the baking quality. This work has been carried on in collaboration with the Bureau of Plant Industry at Washington, and this collaboration has enabled us to undertake the study of samples gathered from the principal wheat growing sections of the United States. A bulletin is now in preparation setting forth the results of investigation, and it is hoped that this will be ready for publication at an early date.

During the past year the extensive series of paint experiments, which have been under way for the past four years, have been continued, and new lines of work undertaken. Additional test fences have been arranged for to enable us to carry the work further. During the coming year some of the earlier experimental fences will need repainting, giving us an opportunity to test the effects of application of new paints over old paints. This line of experiments is attracting wide atten-

tion and has brought to the College a number of prominent investigators to make a special study of the experiments and whose report, when published, will add materially to the knowledge of paint matters and the wearing qualities of paints for North Dakota conditions.

There have also been analyzed during the past year a large number of waters, many samples of formaldehydes, paris green and other products submitted by people of the state. In addition to this several thousand samples of foods, beverages, drugs, etc., have been tested in the Laboratory.

The number of personal letters during the year has amounted to above five thousand. This does not include the circular letters which have been prepared and sent out, also two reports submitted to the County Auditors of the State, as required under the provisions of the Food Law.

During the year there has been prepared and published one bulletin, No. 86, dealing with the subject of "Some Ready-Mixed Paints." These are mainly mixed paints, white leads (so-called), produced and sold largely in the East; our purpose being to determine whether the paints of the Eastern part of the country were in any way superior to those produced and sold in the West. Nine special bulletins have been prepared dealing with matters mainly in connection with foods, drugs, beverages, flours, etc.

A disastrous fire broke out in the Chemical Laboratory on the evening of December 24th, destroying the building, its entire contents and equipment. The only things saved were the official records which were deposited in the vault. This has naturally handicapped the work of the Department. Much of the analytical data of the various Laboratories, which had accumulated during the year and should have formed a part of the present report, was destroyed. It is hoped, however, that a new Laboratory will be built during the coming year. Provisions have already been made for temporary laboratories in the several buildings on the campus so as to carry forward the work which was in progress at the time of the fire. Lines of work outlined for the present year must of necessity be curtailed to a considerable extent.

SUMMARIES OF TEMPERATURE AND RAINFALL.

Since the opening of the Station nineteen years ago, meteorological records have been maintained and the data for each year has been published in preceding annual reports. For the past year we present the following:

TEMPERATURE AND RAINFALL FOR 1909.

Month	Mean	Maximum	Mean of Maxima	Minimum	Mean of Minima	Rainfall in in.
January	4.35	38	13.74	-31	-5.03	.014
February	9.21	34	17.17	-16	1.25	.25
March	24.95	45	32.80	-4	17.09	.29
April	35.5	67	45.30	12	25.70	.61
May	53.43	83	64.45	20	42.41	4.15
June	65.36	91	75.53	40	55.03	2.73
July	69.70	93	80.09	51	59.32	2.76
August	71.93	93	83.64	42	60.25	3.52
September	59.66	88	72.70	36	46.63	1.45
October	44.45	89	53.93	17	34.96	1.29
November	28.53	69	38.73	-4	18.33	1.11
December*	8.87	42	14.91	-21	2.83	1.47
Total & Means	39.66		49.41		29.89	19.64

*The record for the month of December is for twenty-four days only; for the last days of the month the records were lost by the destruction of our instruments.

The mean annual temperature for a number of years preceding 1906 averaged 39.40°. In 1906 the average for the year was quite a little above that for the preceding year, being 47.3°; while for 1907 the average was 37.26°; for 1908, 42.26°; and for the past year 39.66°, or very nearly the average for the earlier years.

Summarizing our results for temperature we have:

Mean of temperature for 1906 ..... 47.3°
Mean of temperature for 1907 ..... 37.26
Mean of temperature for 1908 ..... 42.26°
Mean of temperature for 1909 ..... 39.66°
Mean of maxima temperature for 1907 ..... 48.02°
Mean of maxima temperature for 1908 ..... 52.38°
Mean of maxima temperature for 1909 ..... 49.41°
Mean of minima temperature for 1907 ..... 26.85°
Mean of minima temperature for 1908 ..... 31.51°
Mean of minima temperature for 1909 ..... 29.89°
Maximum temperature registered July 20 and Aug. 3 93.00
Minimum temperature registered Jan. 6th ..... -21
Range of temperature for 1909 ..... 114.00°

The rainfall for 1909 was 19.64 inches as compared with 18.98 inches in 1908, and a maximum of 30.76 inches in 1905. The average rainfall for fifteen years preceding 1907

was 21.26 inches. The annual rainfall by years since 1892 is shown in the following:

	1892	1893	1894	1895	1896
Rainfall, inches	20.73	16.17	18.72	16.05	21.77
	1897	1898	1899	1900	1901
Rainfall, inches	22.50	16.36	21.20	25.54	25.68
	1902	1903	1904	1905	1906
Rainfall, inches	23.16	23.81	20.26	30.76	17.70
	1907	1908	1909		
Rainfall, inches	15.34	18.98	19.64		

For the past sixteen years the minimum rainfall has been 15.34 inches in 1907, and the maximum rainfall 30.76 inches in 1905.

MONTHLY RECORD OF SUNSHINE.

The record for sunshine during the past year has been taken by means of a Friez Photographic instrument. No correction has been made for early morning and evening sunshine. This is estimated at about 12 per cent more than the recorded sunshine. The record for the month of December was destroyed in the burning of the Laboratory and, therefore, only eleven months are given in the accompanying table:

SUNSHINE RECORD FOR 1909.

	Total Hours		Hours of Daily Means		% ps'ble
	Possible	Recorded	Possible	Recorded	Sunsh'e
January	279.1	74.1	9.0	2.39	26.11
February	298.1	92.5	10.25	3.3	32.55
March	369.0	129.4	11.9	4.17	35.48
April	407.3	156.5	13.5	5.21	38.33
May	456.3	170.5	14.71	5.5	39.0
June	475.0	237.9	15.83	7.93	50.07
July	480.2	257.1	15.49	8.25	53.63
August	441.8	266.9	14.25	8.61	60.68
September	378.3	231.71	12.60	7.70	61.29
October	337.6	137.2	10.89	4.42	40.31
November	281.6	79.7	9.38	2.66	27.66
December	267.1	*	8.61	*	*
Means	372.61	166.68	12.20	5.46	42.28

*Lost.

The mean record above is for eleven months and 17 days. The record for the last days of December were destroyed in the burning of the chemical building.

RECORD OF WIND VELOCITY.

A Friez Wind Gage and Aneometer Register are employed for registering the wind velocity, the data for which is presented in the following table:

Date	JANUARY*			FEBRUARY		
	Total M.	Mean V.	Max. V.	Total M.	Mean V.	Max. V.
1	467	19.4	25	264	11.0	12
2	259	10.7	15	166	6.9	8
3	212	8.8	39	176	7.3	17
4	624	26.	39	378	15.7	30
5	549	22.8	28	288	12.0	21
6	107	4.4	22	413	17.2	27
7	435	18.1	21	523	21.7	23
8	319	13.2	20	551	22.9	42
9	334	13.9	20	886	36.9	40
10	373	15.5	21	400	16.6	15
11	279	11.6	22	322	13.4	22
12	378	15.7	20	287	11.9	12
13	222	9.2	38	154	6.4	15
14	530	22.	25	187	7.7	19
15	248	10.3	36	413	17.2	30
16	613	25.5	36	363	15.1	12
17	259	10.7	36	256	10.6	17
18	647	27.0	31	275	11.4	23
19	296	12.3	37	303	12.6	21
20	***	***	***	286	11.9	18
21	***	***	***	106	4.4	9
22	359	14.9	19	105	4.3	24
23	308	12.8	32	534	22.2	37
24	400	16.6	14	409	17.0	24
25	271	11.2	19	409	17.0	27
26	361	15.	20	317	13.2	19
27	317	13.2	20	226	9.4	18
28	631	26.2	55	317	13.2	22
29	979	40.7	40			
30	316	12.1	38			
31	742	30.9	40			
Means and Totals	11835	16.1	28.55	9314	13.82	21.57

*Two days record lost for January. ***Lost.

Date	MARCH			APRIL		
	Total M.	Mean V.	Max. V.	Total M.	Mean V.	Max. V.
1	331	13.7	24	415	17.2	33
2	529	22.0	30	648	27.0	33
3	218	9.0	13	272	11.3	29
4	175	7.2	14	478	19.9	25
5	177	7.3	17	294	12.2	17
6	425	17.7	31	178	74.1	34
7	242	10.0	11	610	25.4	30
8	110	4.5	17	322	13.4	22
9	447	18.6	30	180	7.5	42
10	508	21.1	26	758	31.5	44
11	170	7.0	15	365	15.2	23
12	275	11.4	19	369	15.3	25
13	439	18.2	30	388	16.1	16
14	321	13.3	17	158	6.5	20
15	254	10.5	27	333	13.8	18
16	432	18.0	21	285	11.8	17
17	412	17.1	27	404	16.8	28
18	308	12.8	22	474	19.7	26
19	238	9.9	22	245	10.2	19
20	416	17.3	28	364	15.1	32
21	615	25.6	32	450	18.7	37
22	393	16.3	19	373	15.5	24
23	432	18.0	30	188	7.8	11
24	549	22.8	30	218	9.0	26
25	313	13.0	31	324	13.5	30
26	637	26.5	41	579	24.1	45
27	330	13.7	17	227	9.4	20
28	306	12.7	27	508	21.1	33
29	519	21.6	21	465	19.3	32
30	292	12.1	19	768	32.0	42
31	113	4.7	24			
Means and Totals	10926	14.63	23.61	11640	18.33	27.76

Date	MAY			JUNE		
	Total M.	Mean V.	Max. V.	Total M.	Mean V.	Max. V.
1	799	33.2	38	353	14.7	18
2	526	21.9	28	224	9.3	14
3	190	7.9	28	125	5.2	17
4	295	12.2	18	337	14.0	23
5	537	22.3	36	340	14.1	17
6	468	19.5	24	249	10.3	20
7	216	9.0	17	363	15.1	23
8	468	19.5	24	254	10.5	18
9	364	15.1	21	213	8.8	10
10	280	11.6	20	154	6.4	10
11	357	14.8	22	121	5.0	9
12	556	23.1	41	124	5.1	12
13	414	17.2	26	131	5.4	22
14	271	11.2	16	328	13.6	20
15	224	9.3	23	176	7.3	20
16	461	19.2	30	388	16.1	27
17	316	13.1	23	283	11.7	18
18	326	13.5	20	160	6.6	21
19	152	6.3	15	456	19.0	24
20	197	8.2	14	505	21.0	27
21	212	8.8	16	425	17.7	27
22	300	12.5	19	473	19.7	27
23	209	8.7	10	243	10.1	26
24	171	7.1	17	187	7.7	12
25	307	12.7	21	328	13.6	29
26	336	14.0	21	168	7.0	21
27	295	12.2	24	271	11.2	18
28	132	5.5	19	253	10.5	28
29	371	15.4	29	478	19.9	26
30	575	23.9	36	390	16.2	22
31	344	14.3	26			
Means and Totals	10669	14.29	23.29	8500	11.76	20.2

Date	JULY*			AUGUST**		
	Total M.	Mean V.	Max. V.	Total M.	Mean V.	Max. V.
1	276	11.5	16	157	6.5	17
2	202	8.4	22	305	12.7	16
3	404	16.8	23	356	14.8	24
4	132	5.5	16	240	10.0	16
5	265	11.0	17	300	12.5	20
6	196	8.1	16	399	16.6	23
7	233	9.7	23	***	***	***
8	354	14.7	33	176	7.3	17
9	401	16.7	18	263	10.9	14
10	301	12.5	20	223	9.2	16
11	***	***	***	270	11.2	15
12	***	***	***	220	9.1	14
13	218	9.0	9	228	9.5	13
14	163	6.7	28	218	9.0	12
15	377	15.7	27	173	7.2	12
16	310	12.9	19	148	6.1	10
17	123	5.1	16	139	5.7	13
18	232	9.6	16	257	10.7	21
19	451	18.7	31	165	6.8	14
20	566	23.5	31	225	9.3	25
21	268	11.1	15	446	18.5	43
22	320	13.3	26	687	28.6	46
23	363	15.1	22	169	7.0	28
24	119	4.9	17	411	17.1	24
25	312	13.0	19	239	9.9	19
26	411	17.1	28	178	7.4	13
27	366	15.2	27	299	12.4	23
28	511	21.2	29	476	19.8	25
29	283	11.7	13	384	16.0	25
30	133	5.5	17	255	10.6	24
31	237	9.8	24	404	16.8	22
Means and Totals	8527	12.20	21	8410	11.64	20

*Two days record lost for July.
**One days record lost for August.
***Lost.

Date	SEPTEMBER*			OCTOBER		
	Total M.	Mean V.	Max. V.	Total M.	Mean V.	Max. V.
1	240	10.0	22	246	10.2	18
2	368	15.3	16	309	12.8	14
3	190	7.9	12	133	5.5	8
4	220	9.1	29	167	6.9	19
5	408	17.0	25	322	13.4	22
6	406	16.9	29	466	19.4	23
7	261	10.8	19	540	22.5	34
8	293	12.2	18	544	22.6	38
9	220	9.1	13	329	13.7	23
10	274	11.4	16	462	19.2	28
11	290	12.0	19	598	24.9	37
12	***	***	28	755	31.4	35
13	373	15.5	22	566	23.5	26
14	365	15.2	20	387	16.1	23
15	199	8.2	27	353	14.7	19
16	298	12.4	23	261	10.8	16
17	303	12.6	24	129	5.3	10
18	383	15.9	31	150	6.2	12
19	526	21.9	30	154	6.4	30
20	329	13.7	21	563	23.4	30
21	329	13.7	25	512	21.3	30
22	184	7.6	20	481	20.0	29
23	340	14.1	18	195	8.1	14
24	249	10.3	19	293	12.2	26
25	145	6.0	18	408	17.0	15
26	404	16.8	26	325	13.5	31
27	612	25.5	34	497	20.7	30
28	488	20.3	22	236	9.8	32
29	305	12.7	18	599	24.9	34
30	168	7.0	11	485	20.5	20
31				240	10.0	17
Means and Totals	9170	12.70	22	11705	15.70	31

*One days record lost for September.

***Lost.

Date	NOVEMBER*			DECEMBER**		
	Total M.	Mean V.	Max. V.	Total M.	Mean V.	Max. V.
1	297	12.3	19	586	24.4	23
2	230	9.5	18	***	***	***
3	234	9.7	23	***	***	***
4	196	8.1	11	396	16.5	18
5	161	6.7	12	257	10.7	20
6	293	12.2	26	242	10.0	21
7	502	20.9	29	389	16.2	18
8	417	17.3	26	319	13.2	20
9	334	13.9	36	387	16.1	17
10	728	30.3	37	235	9.7	8
11	777	32.3	43	170	7.0	16
12	371	15.4	22	272	11.3	16
13	372	15.5	27	124	5.1	9
14	479	19.9	53	125	5.2	22
15	***	***	***	360	15.0	21
16	***	***	***	206	8.5	37
17	296	12.3	21	673	28.0	35
18	259	10.7	28			
19	373	15.5	25			
20	330	13.7	29			
21	430	17.9	28			
22	169	7.0	13			
23	146	6.0	35			
24	556	23.1	32			
25	445	18.5	24			
26	375	15.6	23			
27	279	11.6	16			
28	254	10.5	18			
29	245	10.2	25			
30	518	21.5	27			
Means and Totals	10066	14.93	26	4741	13.12	20

*Two days record lost for November.

**The record for December is very incomplete, being for only 15 days, a destructive fire having destroyed the building and records.

***Lost.

The total number of miles recorded for the year ending Dec. 31st, have been as follows:

	Miles.	
January	11,835	(1)
February	9,314	
March	10,926	
April	11,640	
May	10,669	
June	8,500	
July	8,527	(2)
August	8,410	(3)
September	9,170	(4)
October	11,705	
November	10,066	(5)
December	4,741	(6)
Total	115,494	

(1) Records lost for two days in January.
(2) Records lost for two days in July.
(3) Records lost for one day in August.
(4) Records lost for one day in September.
(5) Records lost for two days in November.
(6) Records lost for sixteen days in December.

The actual number of days recorded for the years are 325. The velocity averaged 358 miles per day, or 14.9 miles per hour. At the same rate for the forty days unrecorded, the total for the year would be 116,090 miles. The maximum velocity for the year was in January, 55 miles per hour.

EVAPORATION FROM A WATER SURFACE.

For eight summers past there has been kept a record showing the daily evaporation of water from a water surface for the five principal growing summer months. This work is carried on in connection with the soil experiments and the study of plant nutrition intended for the purpose of gaining information with regard to the movement of waters in the soil.

The method pursued has been described in previous reports and need not be repeated.

The following table shows the amount of water evaporated daily for the five months as expressed in inches:

Date	May	June	July	August	September
1	.0	.10	.0	.50	.0
2	.0	.10	.10	.70	.0
3	.0	.50	.30	.0	.20
4	.0	.30	.10	.20	.20
5	.15	.15	.20	.20	.30
6	.0	.15	.40	.20	.20
7	.30	.10	.30	.0	.30
8	.10	.30	.20	.0	.20
9	.20	.10	.30	.10	.30
10	.40	.15	.20	.0	.50
11	.20	.15	.30	.0	.50
12	.10	.0	.0	.0	.30
13	.10	.0	.10	.10	.70
14	.20	.10	.30	.10	.30
15	.10	.10	.20	.20	.10
16	.30	.0	.10	.30	.10
17	.10	.20	.30	.20	.40
18	.50	.20	.10	.30	.40
19	.50	.20	.30	.30	.10
20	.20	.30	.10	.40	.30
21	.30	.10	.0	.40	.20
22	.0	.20	.10	.0	.0
23	.0	.10	.10	.0	.0
24	.10	.20	.30	.0	.20
25	.0	.0	.30	.0	.10
26	.20	.0	.30	.10	.20
27	.20	.0	.40	.20	.20
28	.25	.15	.0	.0	.40
29	.0	.0	.40	.10	.20
30	.0	.0	.20	.40	.10
31	.0		.30	.20	
Totals and Means	4.50 .145	3.95 .131	6.30 .203	5.20 .167	7.00 .233

The amount of evaporation from a water surface in the five principal growing months, May, June, July, August and September, was 26.95 inches, a monthly average of 5.39 inches or a daily average of .176 inches.

A summary for the past eight years is shown by months in the following table:

INCHES OF EVAPORATION.

Month	1902	1903	1904	1905	1906	1907	1908	1909
May	6.48	4.30	6.40	4.37	3.63	4.53	6.08	4.50
June	5.75	8.69	5.40	5.60	3.57	5.02	4.83	3.95
July	4.77	13.26	8.05	6.67	5.84	4.96	8.89	6.30
August	6.62	12.07	8.30	6.51	5.21	3.70	12.24	5.20
Sept.	4.50	3.55	2.29	3.28	4.11	2.46	5.20	7.00
Totals	28.12	41.87	30.44	26.43	22.36	20.67	37.24	26.95

The range in the amount of evaporation from a water surface for the past eight years has been very large. When this data is examined however, in connection with other meteorological data, including sunshine, temperature, wind, relative humidity of atmosphere and rainfall, there is offered much instructive information with regard to the matter of variation in soil moisture and the movement of the same for the several seasons.

The rainfall by months for the same period has been as follows:

INCHES OF RAINFALL.

Month	1902	1903	1904	1905	1906	1907	1908	1909
May	4.25	2.78	1.47	5.77	3.03	1.57	3.02	4.15
June	3.97	.56	3.83	5.00	3.11	3.12	2.60	2.73
July	2.54	2.62	2.83	5.17	2.68	2.39	2.78	2.76
August	2.95	4.61	.69	6.82	2.22	2.84	2.55	3.52
Sept.	1.61	5.61	3.49	3.47	1.18	3.90	2.54	1.45
Total	14.32	16.18	12.30	26.23	12.22	13.82	13.49	14.61

The difference in rainfall as compared with evaporation for the several years, which is shown in the following table, is of special interest:

EVAPORATION TIMES THE RAINFALL.

1902	1.96
1903	2.58
1904	2.47
1905	1.003
1906	1.829
1907	1.489
1908	2.76
1909	1.804

The last table indicates a very wide range in the amount of evaporation as compared with rainfall for the past eight years, but when this data is studied in connection with that of sunshine, relative humidity, temperature, and wind, which have varied markedly for the several seasons and so to a considerable extent modify the rate of evaporation, we find harmony in the results and much of interest for one who is studying the subject of water movement in the soil and its relation to plant growth.

STOCK FOODS AND FEEDING STUFFS.

Lab. No.

141—Prussian Stock Food, Prussian Remedy Co., St. Paul, Minn.

142—Shorts, Fargo Mill Co., Fargo, N. D.

143—Wheat Bran, Fargo Mill Co., Fargo, N. D.

144—Mixed Feed, Fargo Mill Co., Fargo, N. D.

145—McConnon's Poultry Tonic, McConnon & Co., Winona, Minn.

146—McConnon's Stock Tonic, McConnon & Co., Winona, Minn.

147—Wahpeton Stock Tonic, Wahpeton Stock Food Co., Fairmount, N. D.

148—Guarantee Stock Food, Guarantee Stock Food Co., Grand Forks, N. D.

149—Shorts, Medina Milling & Elevator Co., Medina, N. D.

150—Wheat Bran, Medina Milling Co., Medina, N. D.

151—Wheat Middlings, S. W. Bradford, Ayr, N. D.

ANALYSES OF STOCK FOODS.

Lab. No.		Moisture	Ash	Fat	Proteids Nx6.25	Crude Fibre	Nitrogen Free Ext.
141	Prussian Stock Tonic	4.42	18.13	8.36	11.87	12.08	45.14
142	Shorts	5.26	4.23	5.93	16.43	7.34	60.81
143	Wheat Bran	9.02	5.84	4.82	14.87	23.81	41.64
144	Mixed Feed	9.23	6.78	5.08	13.25	10.94	54.72
145	McConnon's P'y Tonic	4.19	37.57	2.51	21.31	8.28	26.14
146	McConnon's St. Tonic	4.01	18.72	5.17	15.18	15.06	41.86
147	Wahpeton Stock Tonic	7.83	10.15	6.98	21.12	10.13	43.81
148	Guarantee Stock Food	4.63	10.25	5.87	23.93	9.25	46.07
149	Shorts	10.50	3.56	4.70	19.87	3.49	57.88
150	Wheat Bran	8.62	6.94	3.83	17.50	10.80	52.31
151	Middlings	7.34	4.41	5.11	14.37	8.80	59.97

The fire which destroyed the Chemical Laboratory makes it impossible for us to present analytical data for many of the lines of work which have been carried on during the year, including the analysis of formaldehyde, paris green and sugar beets. Many lines of soil work were in progress, the results of which were also lost in the fire.

The results of investigation made upon wheats, flours and milling products, including baking tests and determinations of gluten, gliadin, and the full analysis of flours milled at the experimental mill, are reserved for publication as a bulletin.

Respectfully submitted,

E. F. LADD, Chemist.

DEPARTMENT OF BOTANY

Director J. H. Worst.

Sir: I herewith transmit to you an outlined report of the work of the Department of Botany of the North Dakota Experiment Station for the year ending December 31, 1909.

For the first time in many years the working force of the Department has remained unchanged. This is a matter of considerable gratification because in the permanency of the workers is the only hope of effective investigation.

The work undertaken may be said to fall under three essential general lines. (1) Adams' investigations, which are confined essentially to new lines of work upon wheat, flax and potatoes and is specially concerned with breeding propositions and studies upon plant diseases. (2) Hatch investigations, including the more general lines of experimentation, tentative trials and demonstration or check trials upon studies already more or less perfected. Along this line the chief work has been upon weeds with a view of ascertaining best methods of eradication and upon a plant survey of the state with a view of listing all plants of the state in relation to the geological survey of the soils and also with the view of obtaining a comprehensive list of the fungous plants of the state. (3) Work under state aid which consists essentially of the supervision of the work directed by the Seed Control Act, or Pure Seed Law. The plant survey, in part, and the extension work consisting largely of correspondence with teachers and farmers with a view of bringing the experimental results of the Department plainly before the farmers and schools of the state.

The Staff: As Head of the Department, my time is largely occupied with executive work and correspondence. All experiments undertaken by the assistant force are, however, carefully outlined and so directed that the effort of each worker is directly co-ordinated with the main lines of general experimental work which the Department is trying to execute. A portion of the available time for pure investigation is used for study upon new lines of investigation.

or tentative experiments which will aid the work in the different lines of experiment which are now definitely mapped. Professor W. B. Bell has charge of the field work of the Plant Survey in association with the Economic Geological Survey. Professor H. F. Bergman places the time which he is able to devote to Experiment Station work upon mycological investigations, giving special attention to the various fungous plants of the state. Professor T. D. Beckwith's work has been confined essentially to the studies upon fungous and bacterial content of wheat soils. Assistant Professor O. A. Stevens has charge of the investigations in the Seed Laboratory and of the purity and germination tests upon seeds.

Each of these workers has filed a detailed report of work for the year, extracts of which will be embodied in this report.

In previous biennial reports and in our annual report of 1909, I have recommended the enactment of a Pure Seed Law. In the 19th annual report of this Department there was included the draft of a bill which was thought desirable. I am now pleased to say that the last Legislative Assembly enacted this bill in all its essential features. As the law calls for an annual report of the work by the Experiment Station, as State Seed Commissioner, I have embodied in this report an outline of the essential features of the work conducted under the law to January 1, 1910.

Studies Upon Wheat: We have continued a number of lines of investigation upon wheat, laid out in previous years: (a) Constant cropping studies with a view to the effect upon the development of diseases in the crop and to facilitate possible selection with reference to disease resistance; (b) The application of special chemicals, fertilizers and special soil disinfecting agents to ascertain the effect upon the parasitic flora of the soil and to aid in an understanding of the relationship of soil fungi and bacteria to the wheat crop; (c) Mycological studies upon the wheat crop of our special plots and the general wheat crop of the state with a view of obtaining a knowledge of the uniformity of the occurrence of certain little known but peculiar diseases of the wheat crop; (d) Pot experiments under glass planned to act as checks on our field experiments with soils and seeds; (e) Crushing tests conducted upon the grain which is grown upon our specially prepared beds to ascertain the influence of our methods of selection and of soil treatment upon the resistance of the wheat grain to crush-

ing forces; (f) Threshing and weight tests as checks upon the other trials.

A large amount of data has been accumulated in each of these fields and as soon as we can complete the work so as to ascertain the results it is intended to issue a bulletin covering this field.

The net results with reference to diseases of all of the different lines are well summarized in Press Bulletin No. 33, in which it is indicated that the deterioration of yields in wheat of the great wheat fields of the northwest is largely due to the presence of soil and seed borne disease producing parasites not heretofore commonly recognized on wheat, and not necessarily to lost chemical fertility.

The following outline of the work upon soils and wheat diseases is summarized from the various field experiments of the Department and from the Annual Report of Professor Beckwith, upon the culture work done in the Laboratory of Plant Pathology and Bacteriology.

Pot Experiments in Greenhouse.—Continuous Culture of Wheat in Sand and Soil: These experiments were started in the spring of 1907 and in a preliminary way as a check upon the Whitney soil toxin theory. A new series was started in December, 1907, and the following outline of the experiments is here recorded: A double series of twelve-inch earthen pot cultures were set up in the greenhouse. In one series the medium used was clean crushed quartz of mixed character, such as to afford a good compact pure sand. In the other series the medium used was virgin prairie soil in contrast with old wheat soils. The object has been to find what changes in yield might take place in continuous cropping to wheat and to ascertain if possible the causes. The method pursued was to plant a selected strain of pure bred wheat, the grains being of equal weight and of like pedigree. After germination the number of plants was reduced so as to allow growth to maturity. Whenever leaves dried to a point preparatory to falling they were clipped and saved, and at harvest time the total dry weight of straw and grain was taken and recorded. Cultures were made at different times to ascertain the number of soil bacteria present and the identification of fungi present in the soil of the pots. Two crops have been allowed to mature and a third is now growing.

In order to furnish a proper amount of plant food to these pots the sand pot cultures have been fed with soil extracts prepared according to a plan laid out for each in-

dividual pot. It was considered likely that the amount of plant food in the soil culture pots was sufficient, and therefore they have been watered only with distilled water. In addition, during the first year once a week 500 cc. of the following plant solution was added to the sand culture series. The formula is substantially that recommended by Sachs and is as follows:

Distilled water	1000.00 cc.
Calcium nitrate	1.00 gm.
Potassium chloride	0.25 gm.
Magnesium sulphate	0.25 gm.
Potassium mon-acid phosphate	0.25 gm.

In the sand culture series the pots with the solutions have been as follows:

Pot No. 4 watered with a filtered solution from old wheat soil.

Pot No. 5 watered with a decanted solution from old wheat soil.

Pot No. 6 watered with a solution from old wheat soil, decanted and then sterilized in autoclave.

Pot No. 7 watered with a filtered solution from virgin prairie soil.

Pot No. 8 watered with a decanted solution from virgin prairie soil.

Pot No. 9 watered with a solution from virgin prairie soil, filtered and sterilized in autoclave.

The method used in preparing these solutions was to put 400 grams of the soil designated in 4000 cc. distilled water, stir frequently for forty-eight hours in order to allow materials to go into solution.

In order to ascertain whether or not there was sufficient plant food in these solutions, chemical examinations were made, which yielded results as follows: (Results expressed as parts per million.)

Solutions from virgin prairie soil:

Nitrogen as ammonia	0.65
Nitrogen as nitrate	a trace
Calcium as CaO	74.60
Magnesium	7.24
Phosphorus as phosphorus pentoxide, qualitatively.	positive

Solutions from old wheat soil:

Nitrogen as ammonia	0.35
Nitrogen as nitrate	6.48
Calcium as CaO	45.90
Magnesium	1.10
Phosphorus as phosphorus pentoxide, positive qualitatively.	

Solutions from flax-sick soil:

Nitrogen as ammonia	0.39
Nitrogen as nitrate	21.30
Calcium as CaO	49.20
Magnesium	0.24
Phosphorus as phosphorus pentoxide, positive qualitatively.	

These solutions were added about every ten days. 500 cc. distilled water per pot was added when necessary to keep the soil or sand in good growth moisture. The results of these experiments are expressed in the table appended:

TABLE I.

WHEAT, CONTINUOUS CULTURE EXPERIMENTS, GREENHOUSE.

No.	Medi'm	Cp.wt. 1st yr.	Cp.wt 2d yr.	Soil count May 14, '08	Soil count Oct. 15, '08	Soil count Dec. 15, '08	Soil count Feb.15,'09
1	Soil	9.0	21.7				
2	Soil	.....	28.2				
5	Soil	23.1	47.1				
4	Sand	37.5	10.5	505,000	55,500	45,160,000	1,822,000
5	Sand	33.0	11.3	590,000	1,533,000	21,991,000	722,000
6	Sand	36.9	9.55	865,000	133,300	23,954,000	3,110,800
7	Sand	60.4	12.8	1,125,000	344,000	270,963,000	3,444,100
8	Sand	42.6	10.2	1,650,000	144,400	9,032,000	955,400
9	Sand	83.0	13.4	1,375,000	155,500	32,397,000	5,110,600

TABLE II.

FLAX, CONTINUOUS CULTURE EXPERIMENTS, GREENHOUSE.

Pot	Medium	Plants	Dry wt. 1st yr.	Av. wt. Av.pl'ts	Plants	Dry wt. 2nd yr.	Av. Wt. Av.plants
1	Sand	5	11.0	2.2	15	4.0	0.27
2	Sand	5	12.5	2.5	14	3.1	0.22
3	Sand	5	6.4	1.28	12	3.5	0.29
3	Soil	4	11.5	2.88	8	12.8	1.60
4	Soil	5	9.0	1.8	10	13.6	1.36
6	Soil	6	16.5	2.75	2	1.8	0.9
7	Soil	5	9.8	1.96	1	2.9	2.9

After the first and second crop thorough qualitative determinations were made of the fungi present in these pots by plating out on an agar medium made by adding 1½ per cent of agar to a soil solution made according to the foregoing method from virgin soil. The results showed that *Spicaria* was present in all the pots, together with *Alternaria* and *Macrosporium*. The wheat stubble, after having been cut off three weeks, and being left in the pot showed a very decided blackening and examinations made of this black area which appeared on the cut ends of the stubble showed the presence of quantities of *conidia*, of *Macrosporium* and *Alternaria*. It will be noticed that the second crop, dry weight, in all of these pots, is much smaller than the first crop dry weight. This may possibly be due to some deterioration in the amount of plant food present, but appears to be due rather to the presence of these fungi, although between each crop, all pots which are watered with filtered or with filtered and decanted solutions were thoroughly sterilized at fifteen points pressure in the autoclave for 45 minutes.

The work in these pot experiments did not disprove the Whitney toxin theory, but gave no evidence in favor of it. They did, however, give definite evidence in favor of the presence of seed borne diseases.

Mycological Studies upon Wheat: Approximately one thousand cultural and microscopic examinations have been made by Prof. Beckwith during the last six months upon the wheat crop of 1909 growing upon the experimental plots of the Botanical Department, with a view to ascertain what percentage of the plants in the various plots is infected with certain indefinite fungi under consideration in our various experiments. The plots on which these fungous studies were conducted consisted of a series of twenty plots, approximately twenty feet square, which are handled separately so as to prevent as far as possible the transfer of soil organisms from plot to plot. The area selected for the experiments is one which has been continuously in wheat since the College obtained the land, and which had a record of nineteen crops previously. It is probable that there have been thus approximately forty consecutive crops of wheat. The soil is typically even as to its characteristics, though rather low lying. Since the plots have been laid out, careful provision has been made to avoid flooding. In some cases the plots have received special fertilizers and in other cases none. In others the soil has been treated in a manner tending towards disinfection. The studies were made di-

rectly upon the wheat plants at the period between heading and maturity, so as to be sure of parasitism rather than saprophytism of the fungi. The results of this survey as shown in percentages of infection of the plants examined on each plot is shown in two tables, which are here appended:

TABLE III.

UNSTERILE SERIES.

Plot No.	Fertilizer Applied	Node					Internode				
		Colleto-trichum	Macro-sporium	Helmin-thosporium	Cephalo-thecium	Teleuto-spores	Colleto-trichum	Macro-sporium	Helmin-thosporium	Cephalo-thecium	Teleuto-spores
1	Formaldehyde	80	40	100	10	60	60	30	90	10	10
2	Check	90	50	80	30	90	100	40	80	10	40
3	Bone flour	100	90	60	0	90	90	40	60	10	80
4	Rock phosphate	90	90	40	30	80	80	60	30	10	70
5	Potassium nitrate	80	70	40	10	90	70	30	30	0	20
6	Sodium nitrate	100	70	90	40	80	80	40	90	10	100
7	Kainit	100	50	60	0	60	80	50	70	0	40
8	Tankage	100	30	70	10	80	100	40	80	0	40
9	Potassium sulphate	90	50	50	10	50	80	30	60	20	50
10	Lime, unslaked and K_2SO_4	80	70	50	40	30	50	70	20	50	90
11	Mixed fertilizers	100	70	40	10	90	100	50	40	20	60
12	Ferrous sulphate	80	80	20	0	60	80	90	50	10	50
13	Red clover	100	70	40	0	50	100	70	50	0	60
14	Dried blood	90	80	100	0	80	100	60	70	0	50
15	Copper sulphate	80	90	90	10	70	90	100	60	0	80
16	Check	90	70	70	0	70	90	80	40	0	60
17	Compost	100	50	80	0	90	100	10	20	0	100
18	Check	90	50	60	0	40	80	50	80	10	40
19	Lime, air slaked	100	70	70	10	70	90	20	20	20	20
20	Sodium chloride	60	60	40	0	50	40	50	30	0	20
	Averages	90	65	62.5	10.5	69	83	50.5	58.5	9	54

TABLE IV.

STERILE SERIES.

Plot. No.	Fertilizer Applied	Node					Internode				
		Colleto-trichum	Macro-sporium	Helmin-thosporium	Fusarium	Teleuto-spores	Colleto-trichum	Macro-sporium	Helmin-thosporium	Fusarium	Teleuto-spores
1	Formaldehyde	100	60	70	70	20	50	20	50	20	10
2	Check	50	60	50	70	60	40	20	20	40	20
3	Bone flour	30	40	10	0	20	10	30	20	0	0
4	Rock phosphate	40	90	20	30	60	30	80	50	30	60
5	Potassium nitrate	30	80	20	50	50	30	60	20	30	50
6	Sodium nitrate	90	50	80	60	40	90	30	70	40	10
7	Kainit	30	20	50	20	10	30	20	50	60	20
8	Tankage	20	70	10	40	20	20	30	0	20	0
9	Potassium sulphate	30	60	50	10	30	30	70	30	30	10
10	Lime, air slaked and K2SO4	20	40	50	10	40	20	20	20	0	0
11	Mixed	90	30	30	30	60	60	20	20	30	20
12	Ferrous sulphate	50	50	10	20	20	70	50	0	10	20
13	Red clover	50	70	70	40	40	50	50	70	20	0
14	Dried blood	90	60	100	60	40	90	20	100	60	0
15	Copper sulphate	60	40	20	0	10	50	10	40	0	10
16	Check	60	60	20	20	30	70	20	30	40	20
17	Compost	90	20	60	10	0	80	20	40	10	10
18	Check	70	40	30	50	30	80	20	40	40	10
19	Lime, air slaked	100	70	30	20	50	60	40	20	40	20
20	Sodium chloride	40	60	30	30	40	90	30	0	30	40
	Averages	57	53.5	40.5	32	33.5	52.5	33	34.5	27.5	16.5

While no one of the treatments was sufficient entirely to eliminate the diseases, it is interesting to notice that some of the treatments seem to be effective in making the wheat more susceptible to the chief disease producers, while others have apparently largely reduced the per cent of actual infections. These two facts are much more evident as observed in the field. It is to be remembered that the seed was not treated for any bed, was of same pedigree, and each bed has raised its own seed for three years. In the cultures a small infection of a straw would also count as much in the per cent column as a badly attacked straw. The table thus does not show the real effective crop destruction.

The first series of cultures (See table I) was intended to show what genera of fungi would have spores or vegetative mycelia on, or in the various parts of the wheat

plant, the idea being to show, not what per cent of specific infection had taken place, but rather what potentialities for such infection might be present. The method followed was to select from each of the twenty beds at random ten wheat plants making 200 plants from the strip. These plants were selected haphazard in order that as representative a survey as possible with the time at hand might be obtained. The method pursued for this examination was to place a part of the specimen in a warm moist atmosphere in order that any fungous spores present might germinate and then be examined microscopically.

Germination tubes were prepared by placing a plug of absorbent cotton about one-half inch thick in the bottom of a test tube and then moistening it with a little distilled water. The tubes were then plugged and sterilized.

A piece of the nearly mature stem of the wheat about three inches long and cut to include the first node was then placed in each of the tubes. Another section of the plant was also selected, this being cut so as to include the second internode only. These various sections thus composed a double series of 200 each, one, the first nodes of 200 wheat plants, and the other 200 internodes from the same plants. After one week incubation at 30° C. microscopic examination was made. Following is the percentages of nodes showing various contaminations:

Colletotrichum	90.0
Macrosporium	65.0
Helminthosporium	62.5
Cephalothecium	10.5

Following are given the percentages of internodes showing possibilities for infection:

Colletotrichum	83.0
Macrosporium	50.5
Helminthosporium	58.5
Cephalothecium	9.0

This series of cultures thus showed that the spores or vegetative mycelium from some of the fungi which were in the soil are to be found likewise in or on the nodes and internodes of the wheat. The next step was to show whether any of these fungi were infecting the wheat plants or whether the examination had revealed merely the presence of certain fungous spores which had lodged on the outside of the plant and which under proper conditions might appear saprophytically.

It was planned to try to find out whether or not certain of these fungi were living parasitically in the wheat, thus giving rise to a pathological condition.

In another set of cultures, a double series, consisting of 200 nodes and 200 internodes was taken and incubated at 30° C. for seven days. In this last series, however, the stem sections were first sterilized exteriorly by treating with one per cent formaldehyde for fifty or sixty seconds and then washing in sterile distilled water to remove the formaldehyde.

After microscopic examination the following percentages of the sections thus treated showed infection by culture growths as follows:

Nodes.

Colletotrichum	57.0
Macrosporium	53.5
Helminthosporium	40.5
Fusarium	33.5

Internodes.

Colletotrichum	52.5
Macrosporium	33.0
Helminthosporium	34.5
Fusarium	27.5

It will be noticed that in the unsterile series *Cephalothecium* was found, while *Fusarium* is not noted. In the last or sterile series *Fusarium* often occurred while *Cephalothecium* was found but once or twice. This seems to show that surface sterilization was complete for the probable saprophyte was eradicated and the less active parasitic types then had a chance to grow or to become apparent.

Finally we took the roots from some of the plants, selecting those which seemed to show some loosening of the cortex as though some disease condition had obtained. Such specimens of wheat root systems were sterilized thoroughly to do away with all surface infection, and then allowed to germinate in damp chambers. In nearly all cases, *Colletotrichum*, *Fusarium* or *Macrosporium* deveoped, showing root infection. As in the nodes and internodes the infection was usually a mixed one.

These experiments seem then to show that: (1) Old wheat soil is infected with certain fungi. (2) The spores or mycelium of certain of these fungi are to be found normally in and on the wheat plants grown on such land. (3) A certain per cent of the wheat is pathologically infected

with certain of these fungi. (4) Certain of these fungi cause root infections.

Check tests from virgin soil did not show these fungi in any large amount. It is suggestive that part at least of the deterioration in yield in wheat fields in the northwest may be due to infection either from seed borne or soil borne fungi or from the spores of the same wind blown. Confirmatory results have been obtained from numerous samples of wheat straw procured in widely scattered areas of North Dakota.

Fungus Cultures from Soils of Wheat Plots: Believing that current ideas as to lost fertility with regard to the lowered wheat production per acre in the northwest could not be accepted as the whole cause of the deterioration in such yields, it was decided to attempt to learn whether or not there were additional factors which contribute, at least, to the result.

Analyses made from soil solutions taken from soil samples from old wheat lands and from virgin soil fail to show sufficient difference in composition to warrant the assumption that deterioration in wheat yields is due entirely to depletion of plant food in the soil.

The plot of wheat ground selected is known on the Agricultural College farm records as Rotation Plot 32. (See also pages 38 and 40.) In consequence of the continuous cropping to wheat the yields per acre had continually fallen until the yield obtained could be said no longer to be normal for the Red River Valley. Analyses of the soil solutions prepared by adding one part of soil to ten parts of water showed however, a good general supply of plant food, from which we in part reasoned that deficiency of plant food could not be considered the cause of the deterioration of the wheat crop.

In the survey for fungi the following method was used. A soil solution was made by mixing one part of soil with ten parts of distilled water. This mixture was agitated frequently for twenty-four hours, in order that such readily soluble matter as was present in the soil might go into solution. This soil solution was then filtered through Pasteur bougies in order to clarify it and without further treatment was made into a solid medium by the addition of one and one-half per cent of agar-agar. The reaction of this medium was very slightly acid, being 0.2 per cent normal.

Soil samples were collected from a depth of two inches below the surface, using proper precautions to guard against contamination, and a suspension made by adding one gram

of the sample to 10 cc. of sterile distilled water. After two minutes agitation in order to obtain as even a mixture of the soil particles and water as possible, this suspension was plated out on the soil agar. Plates were incubated four days at 29°-30° C. Growth was very slow and much restricted on account of the small amount of nutrient material present in the medium. Fungous and bacterial colonies never grew to large size, and could be fished out without difficulty. After purifying the cultures of fungi, their morphological characteristics were studied on beef agar, potato, sterile wheat straw, etc. The following genera of fungi were found: *Fusarium*, two species; *Colletotrichum*, two species; *Macrosporium*, *Alternaria*, *Spicaria*, *Verticillium*, *Rhapalomyces*, *Cephalothecium*, and *Helminthosporium*. Of these *Fusarium*, *Colletotrichum*, *Macrosporium*, *Alternaria* and *Helminthosporium* might well be suspected of pathogenicity to wheat and other cereals.

Fusarium and *Colletotrichum* have recently been demonstrated by Mr. Thomas Manns, of the Ohio State Experiment Station, (previously Assistant Botanist of this Station), to be parasitic on winter wheats.* It thus seems very likely that we are right in ascribing the characteristic wheat-sickness of old wheat areas to various fungi which spread or propagate in the soil, notably, *Colletotrichum*, *Fusarium* and *Helminthosporium* and possibly *Macrosporium*. These facts, with others cited in this report indicate that large wheat areas of the northwest, usually supposed to be more or less impoverished chemically, through constant wheat cropping may in large part owe their low yielding powers to parasitic causes not heretofore recognized. Pathogenic fungi which live in the soil or seed attack and consequently weaken the wheat plants, causing seed degeneration, etc. thus cutting down the yield even on the most fertile areas. Indeed, on soils in which there is a comparatively large amount of available nitrogen these diseases appear to be excessively destructive. Specific descriptions of the fungi will be given in a bulletin now in preparation.

Bacteriological Content of Wheat Beds on Plot 32: In addition to the fungous studies an attempt has been made to learn something of the bacterial flora of the wheat beds on Plot 32, in order to ascertain if possible the characteristics of the various general kinds of bacterial growths in the soil. With this end in view bacterial counts have been made from samples of soil from each plot. Each sample was collected in a sterile bottle and was taken from two inches

*See Ohio State Experiment Station Bulletin No. 203.

below the surface of the plot as near the center of the plot as possible. Three series of estimations have been made.

(1) A fairly complete series has been worked out, using beef agar as the medium. This agar, made according to the standards of the American Public Health Association would more especially allow the denitrifiers to grow. Consequently the first series shows, approximately, the number of denitrifiers present.

(2) A second series was made, using agar medium after the formula of Lipman, and counts made upon this medium presumably show the number of bacteria which are able to grow upon essentially a non-nitrogenous medium and therefore indicate the relative numbers in the plots which are either nitrifiers or neutrals. It is, of course, not at all likely that the medium was entirely free of nitrogen but these estimations probably represent such bacteria as are able to grow without organic nitrogen.

(3) The third series was prepared with the view of finding out how many bacteria there were in the soil capable of growing in close association with wheat. With an idea of finding out something concerning this point a medium was prepared by making a decoction of mature wheat stems in soil solution. This infusion was allowed to stand over night and at the end of twelve hours was heated for twenty minutes to 56 degrees C. thereby extracting other compounds which might not have been readily soluble in cold water. This medium was then hardened by the addition of 2 per cent of agar. Counts made upon such a medium, therefore would show how many bacteria present in the soil could grow on extract of the juices of wheat in a soil solution. The results of these three series of cultures are given in the table which is appended:

TABLE V.

TABLE SHOWING THE BACTERIAL CONTENT OF SOIL TREATMENT PLOTS UNDER CONSTANT WHEAT CROPPING—BOTANICAL GARDEN ON AGRICULTURAL ROTATION PLOT NUMBER 32.

Plot No.	Treatment of Plot	DENITRIFIERS June, 1909	DENITRIFIERS Feb., 1909	DENITRIFIERS Average	Nitrifiers June, 1909	G'ths on Wht. Agar, Feb. '09
1	Formaldehyde	3,610,700	1,177,600	1,555,300	9,743,500	2,533,000
2	Check	1,999,800	444,400	1,257,900	1,733,160	744,300
3	Bone flour	1,744,270	733,200	1,119,300	3,110,800	1,733,100
4	Rock Phosphate	1,888,700	2,077,570	1,405,400	3,077,470	2,722,900
5	Muriate Potash	3,055,200	844,300	1,735,800	4,332,900	2,700,700
6	Nitrate Soda	1,755,300	755,400	1,452,640	3,888,500	1,944,200
7	Kainit	2,466,400	966,600	1,074,800	3,882,900	1,710,900
8	Tankage	2,444,200	911,000	2,399,700	4,221,800	1,777,600
9	Sulphate Potash	2,777,500	1,444,300	2,491,600	5,777,200	711,000
10	Lime, and Sulfate of Potash	3,388,500	777,700	2,233,100	6,110,500	688,800
11	Mixed Fertilizers	8,332,500	1,566,500	2,874,700	3,421,880	1,899,800
12	Iron Sulphate	2,477,500	711,000	1,208,200	2,499,750	1,999,800
13	Clover	3,133,000	8,665,800	4,096,800	3,110,800	53,328,000
14	Dry Blood	1,610,900	233,300	988,800	3,677,400	1,822,000
15	Copper Sulphate	2,244,200	388,800	1,160,900	4,421,780	Lost
16	Check	1,910,920	244,400	1,544,280	5,666,100	1,666,500
17	3-year-old Compost	1,533,180	911,000	1,463,760	1,810,900	1,299,800
18	Check	1,877,590	166,600	1,133,200	3,566,300	1,111,000
19	Air Slacked Lime	1,111,000	1,910,900	1,483,180	2,299,700	2,777,500
20	Salt	5,132,800	1,333,300	2,566,400	2,510,800	8,332,500

We have numerous other bacteriological records, from this plot, taken in other years, and these records are printed at this time for future reference. It is not now desirable to draw conclusion from the data, though when contrasted with the yield in the plots and with tables III and IV, pages 39 and 40, some very interesting features are noticeable. It will undoubtedly be necessary to have a number of series of cultures taken during different years and months to allow generalization. This table is the beginning of a series of check cultures to be made in the future.

It is interesting to note that the different treatments of the soil have undoubtedly influenced the bacterial content. Notice, for example, the influence of salt, clover, and formaldehyde.

Examination of Miscellaneous Plant Disease Specimens: The following examinations were made in the Laboratory of Plant Pathology by Prof. Beckwith during the last year.

The method pursued in order to eradicate all saprophytes of these examinations and give the parasitic forms an opportunity to develop was as follows:

Culture tubes were prepared by using test tubes, placing a cotton plug about one-half inch thick in the bottom of the tubes, saturating it with distilled water and then a cotton plug in the top of the tube. These tubes were sterilized in the autoclave. Other culture chambers were prepared by using squares of filter paper saturated with distilled water in Petri dishes, and these were then sterilized thoroughly in the autoclave. The specimens to be examined were prepared by dissecting carefully with sterile scissors, treating from fifty seconds to one minute, with one per cent formaldehyde, rinsing with sterile distilled water, and placing the specimen in its culture tube or sterile Petri dish. The specimens were then placed in the incubator at from 28° to 30° C. and allowed to incubate from four to seven days, giving the fungi present a chance to develop, then examined under the microscope and the various fungi present noted. It is assumed that the treatment with formaldehyde followed by thorough rinsing with distilled water is sufficient to eradicate all saprophytic fungi and spores which might be on the exterior of the specimen.

1. Potatoes.—Received from Mr. Geo. McKabe, Ellendale, N. D., June, 1909, *Alternaria*. This specimen showed the so-called blight of potatoes.

2. Ash.—Received from David Bartlett, Cooperstown, N. D., June, 1909. Showed a peculiar condition of the

leaves, shot-hole effect and defoliation of the tree. The disease is worth continued study, *Alternaria.*

3. Iris.—College Campus in front of Library. An examination of the roots showed the presence of *Nematodes*, June, 1909.

4. Box-elder.—St. Thomas, N. D., June, 1909. The disease produced by the fungi seemed to show its point of entry as being the lenticels. Culture experiments reveal the germination of no fungus. Microscopic examination shows that small unicellular fungous spores were present which could not be made to germinate enough for identification under any ordinary cultural methods.

5. Box-elder.—A. C. Campus, in front of Chemistry Building. This tree has shown, yearly, premature defoliation following an appearance of many dead spots on the leaves of the trees and small dark areas on the twigs. Microscopic examination revealed the presence of a species of *Alternaria.* A number of other trees on the College Campus reveal the same disease. Also abound in other plantations.

6. Maple Tree.—701 Tenth Ave. N., Fargo, N. D., Prof. Bolley's yard. This tree has shown continuously lack of chlorophyll and the trouble has not been rectified by the application of salts of iron in various quantities and by different methods of internal chemical treatment. It would appear therefore that there might be some allied trouble which is causing the lack of chlorophyll formation and consequently immature defoliation of the tree. Examination of the leaf shows small dead spots which upon microscopic test show the presence of *Macrosporium.* The petioles show the same disease. It is therefore possible that the apparent weak condition of the tree may be due to infection caused by this type of fungus. This etiolation disease of the soft maple is common throughout the Red River Valley and is a serious one.

7. Popple.—Winnipeg Beach, Man. Gathered by Bolley, 9-'09. Leaves show dead spots. Examination made from the edge of these dead spots from living tissue shows presence of *Macrosporium.* Petioles, *Macrosporium.* Twigs, *Macrosporium.* Here, it is possible, that we have a disease which is caused by *Macrosporium.* This peculiar blight of the popple trees seemed to be common in that part of Manitoba.

8. Canada Thistle.—Winnipeg Beach, Man. Gathered by Bolley, September, 1909. Disease causing complete wilting of entire stems. Leaves on living plants show dead brown spots and areas. Examination of the living tissue

close by the dead spots reveals the presence of *Macrosporium* with a very small amount of *Alternaria*. The base of the leaf shows the same thing.

9. Canada Thistle.—Neche, N. D. Gathered by Bolley, September, 1909. Symptoms of the disease same as above. Examination of the leaf reveals the presence of *Macrosporium*. Stock of the plant also shows the same fungus. These two examinations seem to show that there is a *Macrosporium* which is pathogenic to Canada Thistle. It is suggested that if this fungus were cultivated we might be able to find in its use a natural enemy to the spread of the Canada Thistle in the northwest. It is also possible that this parasite is the real cause of the sterility often observed of the blossoms of the thistle on certain areas.

10. Ragweed.—Fargo, N. D., September, 1909. Gathered by Bolley. The leaves show dead brown spots and areas. Examination of living tissue, contiguous to the dead spots shows the presence of a *Macrosporium* which was found likewise on the stock of the plant. Apparently this fungus is pathogenic to Ragweed.

11. Flax.—Minot, N. D., June, 1909. *Macrosporium, Alternaria, Colletotrichum.* The *Macrosporium* and *Alternaria* occurred on the bolls and on sections of the stem. The *Colletotrichum* could be isolated from the various aerial parts of the plants and also from the roots. The first two named fungi are always associated with the disease of flax which this Department in previous reports has called boll blight or boll disease, and the latter, *Colletotrichum*, causes a breaking-over of the flax plants near the ground line.

12. Rust and Flax.—H. A. Bemis, Finley, N. D., July, 1909. Examination of the roots revealed *Colletotrichum*. The same fungus was also found on the leaves.

13. Oats.—Geo. Wilsey, Phoenix, N. D., August, 1909. This specimen showed a blighting of the lower units of the head. The glumes turned white and the fruit did not fill out. Examination of this part of the head showed *Macrosporium* and *Alternaria*. The disease is characteristically common throughout the state and may be appropriately called, "*head blast.*"

14. Oats.—L. J. Schrag, Munich, N. D., August 7, 1909. The microscopic examination showed the same condition as described above. Microscopic and cultural examination showed the plants to be infected as in the above examination, with *Macrosporium* and *Alternaria*.

15. Oats.—Peder Wefold, White Earth, N. D., August 6, 1909. Disease symptoms same as above two specimens. An examination revealed also *Macrosporium* and *Alternaria* in the blighted parts.

16. Oats.—Martin Olson, Geneseo, N. D., December, 1909. Nodes show *Colletotrichum* and *Macrosporium*. Internodes, *Colletotrichum, Fusarium* and *Macrosporium*.

17. Young wheat plants, taken from various wheat plots in the Experiment Station farm under the supervision of the Biological Department. These plants showed a peculiar yellowing in spots on the leaves, evidently not due to rust. Careful examination revealed dark brown spicules of some fungus which was evidently the cause of the disease. Examination of these plants revealed the presence of a certain species of *Colletotrichum* in the leaves. In addition to this, a species of *Fusarium* was also demonstrated.

18. Young wheat plants taken from "steam sterilization plot," so-called, on the Experiment Station farm. Symptoms same as noted above. The plant showed a spent growth. Microscopic and cultural examination gave species of *Alternaria* on the leaves and *Colletotrichum* on the nodes and on the roots. The west side of this plot, where the plants were of good normal size, did not show the presence of *Colletotrichum* in the roots or on the nodes. Some plants gave growths of *Helminthosporium* and *Cylindrosporium*.

19. Wheat.—Geo. Goodmunson, Ryder, N. D., October, 1909. Nodes and internodes showed *Macrosporium*. Glumes and kernels showed the same infecting fungus. Roots showed *Colletotrichum*.

20. Durum Wheat.—Power Farm, Leonard, N. D., October, 1909. (Collector Bolley). Nodes and internodes showed *Macrosporium*. Fruit, *Macrosporium*. Glumes, *Macrosporium*. Roots, *Macrosporium*.

21. This sample of Durum wheat, from St. Thomas, by Bolley, had a stunted growth, apparently caused by the above fungus.

22. Wheat, Blue Stem.—Martin Olson, Geneseo, N. D., December, 1909. Wheat stems showed rust only. No infecting fungus other than this was demonstrated.

23. Wheat.—L. L. Stair, Newberg, N. D., October, 1909. Nodes, *Helminthosporium* and *Macrosporium*. Internodes, *Macrosporium* and *Helminthosporium*.

24. Wheat.—H. C. Miller, Sherwood, October, 1909. Fruit, *Macrosporium*. Glumes, *Macrosporium* and *Alternaria*.

This fungus on the glumes is from very small black spots appearing very much like pin-pricks.

25. Wheat.—John O'Conner farm, St. Thomas, N. D., December, 1909, by Bolley. Nodes, *Colletotrichum, Macrosporium* and *Helminthosporium.* Internodes, *Helminthosporium* with a very little *Colletotrichum.*

26. Wheat.—E. F. Lowe, Courtenay, N. D., 1909. Nodes, *Macrosporium.* Internodes, *Macrosporium* and *Helminthosporium.*

27. Wheat.—Lakota, N. D., December 12, 1909. Nodes, *Colletotrichum* and *Macrosporium.* Internodes, no infecting fungus.

28. Wheat, Blue Stem.—F. W. Revis, Starkweather, N. D., December, 1909. Nodes, rust only. Internodes, *Macrosporium.*

29. Wheat, Blue Stem.—Ole Morstad, Medford, N. D. Nodes, *Macrosporium.* Internodes, *Macrosporium.*

30. Wheat, Blue Stem.—Henry Burris, Conway, N. D., December, 1909. Nodes, *Macrosporium* and *Colletotrichum.* Internodes, *Macrosporium.*

31. Wheat.—N. W. Nicholson, Mohall, N. D., December, 1909. Nodes, *Macrosporium, Colletotrichum.* Internodes, *Macrosporium.*

32. Wheat.—Walter Kelley, Enderlin, N. D., Dec., 1909. Nodes, *Macrosporium* and *Helminthosporium.* Internodes, same fungi.

33. Barley.—J. J. Gokey farm, Dawson, N. D., Collector Bolley, Dec., 1909. Nodes, *Colletotrichum, Helminthosporium* and *Macrosporium.* Internodes, *Colletotrichum, Helminthosporium, Macrosporium* and *Alternaria.*

These examinations associated with many others upon the shrivelled grains now in course of study and taken with our earlier observations noted below leaves no other conclusion than that these diseases are introduced to the new lands of the state gradually through the medium of diseased kernels and finally are propagated abundantly in the old straw, roots and humus of the soils. Our plot experiments (See tables III and IV, pages 39 and 40) together with numerous field studies show that whenever available nitrogen is high and the diseases are present, the destruction of straw and the shrivelling of seed is most intense. The falling or lodging of straw in such cases seems to follow, not so much from over-growth as from weakening of

tissues and inability to mature from loss of root power brought about by the action of the internal parasites.

Pot cultures under control conditions, not fully completed, prove clearly the internal carrying of the disease from crop to crop and also indicate the possible value of proper seed treatment. The new lands of the west and the dryer types of soils as yet suffer less damage than the heavy fertile lands of the Red River Valley.

Previous Observations Upon Wheat, Oat, and Barley Diseases: In previous annual and biennial reports we have mentioned certain obscure diseases as causing blasting or blighting of wheat in such manner as to prevent proper filling of the grains. These notes were taken on certain years when grain filled poorly and, at the time, it was usually assumed that intense heat or moisture were chiefly instrumental in causing the blighting. We now know that intense heat and atmospheric moisture are only conditions which are most satisfactory for the development of the various types of fungi mentioned in this report. If there were no fungi to attack the crop it would probably produce a heavy yield, regardless of the normal moisture and heat conditions of summer weather. In our note book No. 6 of 1893 we have the following records:

"Aug. 14, 1893. There appears to be definite diseases of the glumes of the wheat plant associated with blighting of the immature grains due to a species of *Macrosporium*. There is also present in a number of the growths a species of *Helminthosporium*. Blue-stem wheat is apparently much more heavily attacked than the Fife or Durum varieties."

Under date of Feb., 1898, culture experiments upon the heads and seeds of diseased wheat collected in 1897 gave cultures of a species of *Alternaria*.

Under date of Feb. 16, 1898, heads of Scotch Fife wheat saved from the crop of 1897 produced from the shrivelled berries a species of *Fusarium*. During the summer 1897, observations were conducted upon the maturing wheat crop, including a number of infection tests made upon young blossoms of the wheat plant, from which we came to the following conclusions: "The blasting of the grain in wheat, oats and barley is brought about largely by a species of *Macrosporium*." (From unpublished records in notebook No. 9 of the Botanical Department, page 189.) At this time material was sent to Mr. J. B. Ellis, consisting of heads of diseased wheat and sections of glumes. The results of Mr. Ellis' studies are interesting in the light of our late investi-

gations upon wheat diseases. Among other letters which are on file in this Department I quote the following:

"Newfield, N. J., Aug. 12, 1897.

Dear Sir:—

I have now received the sections of wheat glumes which show the fungus most admirably. Considering the damage this fungus is doing it may perhaps be well to give it a name, at least the *Macrosporium* part of it. I have written on a description of it which I enclose so that you may publish it in some of your bulletins. Please make such alterations or additions as you may think necessary.

Yours truly,

J. B. Ellis."

The description then written by Mr. Ellis for this disease of wheat is as follows:

"*Macrosporium cereale* E. & E. On glumes of living wheat. North Dakota, August, 1897. (Collector, H. L. Bolley)

Sterile hyphae decumbent or prostrate, pale brown, septate, branched; fertile hyphae fasciculate, simple, variously bent, septate, especially near the base, constricted in a moniliform manner, 70-100x3-4 microns, pale brown. Conida various, clavate, or obpiriform, 3-5 septate and more or less constricted, 30-40x10-12 microns, including the short, persistent stipe, one or more of the cells divided by a longitudinal septum. Other conidia are smaller, 8-12x5-7 microns, oblong or subglogose, 1-2-septate or cruciate-septate. The tufts of hyphae are erumpent from small pustules often filled with small hyaline, 1-septate or continuous spores."

Conclusions: These facts and observations upon the characteristics of various genera of fungi which attack the wheat straw and transmit the trouble from year through soil and seed point out clearly why the use of fresh strawy, uncomposted barnyard manures placed on wheat lands have so often been noted as causing light weight, shrivelled wheat when soil fertility, weather and other conditions seemed to be favorable. They also make plain why summer fallow and corn culture sometimes give high yields of plump seed and sometimes seed of low grade as to weight—failure to mature. Ordinarily the best crops are raised on such soils, for the cultivation is unfavorable to the fungi in the soil. However, the good work is often largely ruined by sowing on such well prepared lands seed all or most of the grains

of which are internally infected by disease from preceding crops.

Work With Flax: Soil sickness for flax has been demonstrated by this Department. (See Bulletins 50-55, 1901-1902, and Bulletin 71, 1906.) The primary causes of flax-sick soil were found to be due to two species of *Fusarium*, of which *Fusarium lini* is the most common. A continuation of this work has developed the fact that there is also a destructive canker disease of flax caused by a species of *Colletotrichum*, and also a destructive disease of the flax bolls caused by one or more species of *Alternaria* and *Macrosporium*. These diseases are often very destructive but are less completely destructive than the wilt diseases which bring about the typical flax-sick areas of wilt. The canker disease seems to be confined largely to the western and northwestern more dry areas of the state. I have described these diseases in Bulletin 87, now in print, as being caused by *Colletotrichum lini*. It is characterized by a peculiar breaking off of the nearly mature flax plants at a point near the ground line. The flax breaks over as if chewed off by insects or whipped by the wind. The disease often appears on new areas, that is virgin prairie sod. This may be accounted for in two ways: (1) The presence of the disease upon native wild perennial flax. This I have observed in certain herbarium specimens from Europe and on materials collected in this country. (2) The more probable origin is by the use of internally infected seed. This we have found to be a very common method of introducing the disease. Cankers are already formed upon the seed leaves before they are fully formed in the seed and it is at or near this point that the disease develops on plants which mature from this, causing the breaking over. This canker disease is largely amenable to seed selection and seed treatment but does not seem to respect the flax plants which are wilt resistant.

Co-operative Experiments with Farmers in Seed Breeding: As noted in the previous reports, in the spring of 1908, the seed flax which we had been experimenting on with a view of procuring resistance to wilt was distributed in small lots among a number of farmers representing various counties in the state and various types of soil. With two exceptions the seed was sent only to farmers who could demonstrate that they had soil which was thoroughly wilt infested. Four distinct strains of flax seed were distributed. Records were kept of the exact amount of seed furnished to each man and directions were given as to method of sowing, so

that there would be a check plot of ordinary flax sown for comparison. Forty-nine farmers entered into these co-operative experiments. Full and satisfactory reports have been obtained each year from practically all of the men. In some cases the small lots of flax were lost by various causes. Some lost by hail, some by destruction by cattle, some by mixing at threshing time, etc. The lists of workers and other various reports have been carefully filed for future reference and a card catalog is kept on the amount of seed furnished each man and the amount of seed that he has ready for sale. We are thus able to refer people who are interested in procuring this particular type of seed to the proper parties, and in this way we hope to be able to keep track of the results from the experimental work for two or three years longer. The following general summary may be made:

After two years trial, two of the samples under co-operative trial have given markedly satisfactory results, both as to yield and wilt resistance, in the hands of a large proportion of the growers. One of the samples, N. D. R. 22, has given good yielding capacity, good wilt resisting capacity, but has proven to be quite susceptible to rust, a distinct disease from wilt. We have for this year specially recommended for increase the two samples above mentioned which are now known respectively as N. D. R. 52 and N. D. R. 73. Before recommending N. D. R. 22 for general use we shall carry our experiments somewhat further.

Twenty persons were able to give acreage yields for N. D. R. 52 in 1909 trials. The average of these twenty trials upon sick land was 14.4 bushels per acre. The farmers uniformly were able to report practically complete wilt resistance but in two or three cases there were reports of the attack of the canker disease upon those resistant numbers.

During 1909 several of our co-operating farmers used Minnesota 25 flax, or Primost, as a check or associated crop upon the sick land and as in our experience, found that the Minnesota 25 does not show a particularly high resistance to either wilt or rust. This is in line with the work from the Minnesota Station as they have never recommended Minnesota 25 for special use upon sick land, it being a good yielding flax on clean land. These facts are cited because numerous persons have persistently advertised Minnesota 25 or Primost as "wilt proof," and have thus deceived many farmers, both as to the value of Minesota 25 and as to the merits of the theory of the possibility of procuring wilt resistant flax.

Work With Potatoes: The selection work with potatoes

upon the highly infected potato disease garden has been continued and after a number of years it is becoming evident that there are very few varieties of potatoes which can stand continuous cropping on the same soil. It is evident that a few of the varieties are more resistant to blight and rot than others, but the ordinary rot caused by *Fusarium oxysporium*, does not seem to respect any of the varieties very markedly. By this method of work, the yield in all the varieties has been very materially reduced, indeed to such extent that there is danger of losing the seed. In the next few years a more thorough type of cultivation will be pursued with a few of the better sorts to ascertain whether by special cultivation methods, seed treatment and spraying, good crops can be raised upon the same soil. In previous years no seed treatment, or spraying has been practiced. A trial of artificial fertilizers will be made upon the same soil with a view of ascertaining their effects.

Work with Weeds: Our experimental work upon the eradication of weeds by means of chemicals has been reduced to a smaller plan during the past year than heretofore. We have made trial of a number of new chemical substances and have been specially interested in an attempt to procure some kind of substance which might be destructive to Quack-grass and Sow-thistle without being injurious to the land. As yet trials are essentially negative. We have also been interested in procuring a chemical of cheap grade which would be destructive to dandelions and non-injurious to grasses, and which could be used without staining stone walks, clothing, etc. Along this line Calcium Chloride has been used with considerable success but we are not as yet ready to recommend it as a substitute for Iron Sulfate.

Quite extensive field trials were carried on with Iron Sulfate against dandelions and the results of these are of such nature as to allow us to affirm that it is quite practical to control this pest in large lawns by means of field sprayers and the use of Iron Sulfate, and that the cost is even less than that necessary for the mowing process of such lawns. It must always be remembered, however, that the dandelion is cosmopolitan and seeds are always being blown upon the land. Those who undertake the work must not expect eradication which will last but rather do it as a process which will hold their lawns free from such pests.

The influence of the Iron Sulfate upon the prevention of numerous indefinite diseases of Blue-grass has been exceedingly beneficial. The lawns at the Agricultural College

Campus that were properly sprayed remained much greener and freer from various types of blight producing fungi than any similar untreated areas throughout the season.

The Plant Survey: The Plant Survey of the state has been continued this year in association with the work of the Economic Geological Survey. The field work of the general plant survey was conducted this year in Ransom County. Heretofore we have reported in detail upon the work as done in Williams County in 1906. In 1907 a complete survey was made of the seed bearing plants of Morton and McKenzie Counties. In 1908 the survey work was confined to Richland County. The work of identification takes a very considerable amount of time and is being accomplished by Professor Bergman as rapidly as possible. It will be published in some future report of the Department. All specimens are numbered, labeled and preserved in the Herbarium. At this point it may be well to suggest that the collections being gathered in the Herbarium of Science Hall are not only costing a considerable amount of money, but a large outlay of time of scientific workers. Specimens and data are being added each year which in many cases could only be duplicated after years of patient thought and toil. When Science Hall is completed a fire proof room should be provided for the Herbarium and for the records of this Department. Numerous records of experiments are made each year, the value of which cannot be expected to be fully apparent until associated with the results of experiments yet unfinished.

Special studies were made by Professor Bell upon the rather sandy soils of Sandoun Towship and his report upon this special tract is here appended.

Observations and Recommendations Based Upon the Biological Survey at McLeod, Sandoun Township, Ransom County, N. D., W. B. Bell: Three general lines of farm practice, dairying truck farming and fruit raising are recommended for the most profitable utilization of the large area of sandy soils of which the soils in the vicinity of McLeod are typical. These soils are classified by the United States Bureau of Soils as, 1st, McLeod Sand; 2nd, Fargo Fine Sand; 3rd, Fargo Fine Sandy Loam; and 4th, Dune Sand. These three lines of farming may be practiced by each farmer, thus giving variety and suitable distribution to the work. In this way the fertility of the soils may be conserved and increased and each line of work will contribute to the success of the other lines and thus secure the largest

possible returns from the farm as a whole. It will also help to insure against entire crop loss during seasons which are unfavorable for the production of any one crop.

Owing to the unevenness and irregularity of the surface and soil conditions, cultivation of large fields to a single crop is practically out of the question in most of the area, although there are some tracts where this may be done. The soil and plant life show three well-marked conditions, closely intermingled, which must be met and the cropping be adapted thereto. This necessitates intensive methods of cultivation of comparatively small scattered areas for any particular crop. The surface consists of narrow, irregular sandy ridges separated by winding sloughs in which water often stands most of the year. The soil in the sloughs is black due to the decay of the heavy annual growth of vegetation, and River Bulrushes are the most conspicuous representatives of the plant life. Bordering the slough is an intermediate area with considerable humus mixed with the sand and upon which sedges, small rushes and reed grass with some wheat grass are the predominating elements in the flora. These later areas are the ones from which the wild hay is cut at present and large losses have been sustained through dependence upon these coarse and innutritious materials for winter feed.

Dairying. An abundance of excellent water may be obtained by driving sand-points down to a depth of 8 to 16 feet. Since good water is easily obtainable the chief problem connected with dairying is that of providing a sufficient supply of summer pasturage and winter feed. The sandy ridges afford a considerable amount of nutritious native grasses for pasturage. Early in the season, up to the first of July, Koeleria and Western Stipa are the principal grasses. From the middle to the last of July Mosquite-grass and Racemed Bouteloua are much in evidence while the Broom Beard-grass, or Bunch-grass associated with Forked Beard-grass, Indian Grass and others come to head about the first of August. The pasture value may be considerably increased by scattering Blue-grass seed among the native grasses. Care should be taken not to pasture too many animals upon an area and to prevent the native sod from being broken by trampling as the sand is then apt to blow badly undermining some grass and burying other areas.

Timothy and Brome-grass should be sown over the sandy ridges for pasture and hay. The abundance of native prairie clover and other legumes gives promise of profitable

production of suitable varieties of Alfalfa, such as the Grimm variety, Sand Lucerne and Red Clover.

Along the slough borders where the ground is too wet for these grasses, Red-top, Purplish Wheat-grass, Slender Wheat-grass and Alsike should be used. Corn should be grown for fodder or ensilage and in favorable years may be allowed to stand until mature for the grain.

Sorghum and Kafir corn should also be tried for fodder. Various root crops which are suitable for cattle feed such as Carrots, Turnips and Mangels should also yield large amounts of feed when grown on the sandy ridges and slough borders. Canada Field Peas should also be grown with profit as a source of forage and feed and a means of increasing the soil fertility.

The ordinary crops of wheat, oats, flax, rye and barley will give fair yields on favorable years but should not be depended upon too largely owing to the uncertainty of obtaining a crop and the difficulty of using harvesting machinery because of the surface conditions.

The dairy cows should be prevented from feeding upon the Wild Onions which are common in low situations as they will flavor the milk and lower the grade of the butter. A creamery is already in operation at McLeod and with the above mentioned means of providing feed and pasture a properly selected dairy herd adequately sheltered and cared for should yield a fair profit.

Truck-farming: By truck farming is meant the production, upon a marketable scale, of the various garden vegetables which may be cultivated intensively upon small scattered areas. For such products there is a steady market and with the present railroad facilities and a little enterprise an adequate market could be found. These products may also be used much more largely than at present as a direct means of family subsistence. The low sandy ridges and slough borders are suitable for truck-farming and the manure from the dairy herd may be used to increase the productivity of the soil. Among those things which have a good market value and with proper cultivation are practically sure to yield good returns may be mentioned Potatoes, Beets, Radishes, Carrots, Parsnips, Cabbage, Turnips, Rutabagas, Onions, Lettuce, Tomatoes, Cucumbers, Peas and Beans. Pumpkins, Squashes, Citrons, Water-melons, Sweet-potatoes, Sweet-corn, Pop-corn, and Peanuts should also be given thorough trial. The sandy nature of the soil makes it possible, by using simple forcing-beds suitable for the

farm, to catch fairly early markets and good prices on many of these products.

With proper co-operation of the farmers a cucumber pickling plant should prove profitable to all concerned.

The higher ridges may be used for the early planting and as the season advances and the lower areas become dry enough for cultivation these may be used for the later plantings. Owing to the abundance of water and the ease of obtaining it, by pumping with windmills or gasoline engines, simple private plants of irrigation by pipes or troughs similar to those used in various European countries are feasible and should prove profitable in protecting a truck crop during short, hot, dry periods. Wherever possible sloughs should be drained by running the water into sloughs having a lower level. Consdierable wet land might be made tillable by ridging with the plow.

Fruit Raising. The abundance and fruitfulness of the wild strawberry plants on the sides of the sandy ridges and slough borders gives promise of profitable tame strawberry production in these situations both for home consumption and for the market. The size and quality of the berries is greatly increased by the use of barn-yard manure. Because of the blowing of the sand the fruit should be protected as much as possible by straw placed between the rows or by other means.

Currants and Gooseberries also flourish and produce a good yield on the sandy ridges.

Wild Raspberries, both the red and black varieties, grow commonly and produce good fruit along the sides of sandy ridges and sand dunes where shaded and protected by trees, indicating the possibility of good returns from hardy tame varieties.

Wild plums are also common on the sides and at the base of the sand dunes and hardy varieties of tame plums should thrive over the sandy ridges if properly protected and cared for until well started.

An abundance of Choke Cherries is also produced on the Sand Dunes, while the Sand Cherry grows commonly everywhere on the sandy ridges.

Apples also do well in similar situations in the vicinity and hardy varieties should be cultivated here.

Wild Grapes also flourish on the sides of the dunes among the low trees while Hops are occasional, indicating that tame varieties of these might be grown with profit.

The following trees and shrubs are native and grow

commonly over the dunes and sandy areas: Bur Oak, Quaking Asp, Cottonwood, Bass-wood, Choke Cherry, Juneberry, Silver Berry, Sand-bar Willow, Green Ash, Sand Cherry, Wolf-berry. The Golden Willow and Boxelder make excellent growth on the sandy ridges and low moist meadows. By exercising care in keeping out prairie fires it will be possible to grow effective wind-breaks and to cover the sand dunes largely with trees which would help greatly in preventing the drifting of the sand. Hardy varieties of Pine, such as the Bull Pine, might be used profitably in reforesting the higher dunes and ridges which are not suitable for cultivation or pasturage.

The importance of plants which have a perennial root system or propagate by means of underground stems, suckers, stolons, runners, etc., needs to be strongly emphaized as this gives them an opportunity when once started to keep their roots down to moisture and filling the sand with a net-work of roots prevents its drifting.

As far as possible crops should be selected which mature in July or earlier, that the danger of drouth and hot winds in August may be avoided.

The following is a record of the rainfall at McLeod from June 25th to Sept. 1st, 1909:

Date—	Rainfall, inches.
June 25th	.18
June 26th	.105
July 4th	.015
July 8th	.05
July 12th	.96
July 13th	.01
July 14th	.05
July 17th	.27
July 20th	.675
July 21st	2.65
July 25th	.1
July 28th	.2
July 29th	.01
July 31st	.025
August 3rd	.1
August 6th	.07
August 8th	.7
August 11th	.07
August 14th	.03
August 16th	.08
August 21st	1.14

August 23rd	.7
August 24th	.05
Total	8.240

Among the troublesome weeds which should be controlled in this locality are the following:

Marsh Elder, Ragweed, Pink Cockle, American Cockle Bur, Wild Mustard and Russian Thistle.

Among poisonous plants the following should be noted and guarded against: First, Poison Oak, which is abundant everywhere among trees and shrubbery. Second, Water Hemlock, which is scattered in low situations, and third, Poisonous Zygadenus, which is abundant in the low moist situations.

In addition to the foregoing lines of farm management hogs and poultry should be raised. The hogs may be fed upon the by-products of the dairy and upon the field peas and corn and other materials which otherwise would be wasted. Sunflowers grow luxuriantly and could be grown as feed for poultry. Large sloughs which cannot be drained for cultivation may be utilized in raising ducks and geese because of the large number of snails, water-insects, wild celery, chara and other edible plants upon which water-fowl feed.

Here, as in many parts of the country the way to success lies in careful attention to the many details of widely diversified farming where the work may be largely performed by the members of the family and where industry, intelligence, frugality and thrift are necessary factors.

Herbarium and Mycological Survey: The following outline report by Professor H. F. Bergman contains a statement of the systematic work of enumerating the fungus plants of the state: "During the past year there has been added to the herbarium 923 specimens, partly by exchange and partly by collection. The total number of species added since September, 1908, is 1432. The additions since the last report include plants from Williston and from Richland and Morton Counties. All collections up to that made in Richland County during the past summer have been identified.

A set of forty-four plants was received from Dr. J. F. Brenckle of Kulm. Miss Helen Hoover of Fargo donated to the Herbarium twenty species of Philippine plants collected by E. D. Merrill.

Work upon the key to the flowering plants of North Dakota has been in progress during the year and keys to the

Monocotyledons, except Carex, have been completed. Some revisional work has been done on the Dicotyledons and the construction of keys for their determination is now well advanced.

To the herbarium of Cryptogams there have been added 350 specimens by exchange and collection. The exchanges are specimens sent in return for the fascicles of North Dakota fungi. The third fascicle was sent out March 5, 1909. Material for two more fascicles has been collected and will be sent out during the winter.

The local collections of fungi have been recorded and specimens placed in the herbarium. A number of these are new to the herbarium. Some of them have probably been collected before but no specimens were preserved.

In connection with the investigation plans of the Department upon the cause of deterioration in wheat yields a study was made of diseases affecting wheat. These have nearly all been determined and filed away in the Herbarium. Drawings have been made of several of the more characteristic forms.

The following specimens of fungi, collected in the state, have been added to the Herbarium:

CLASS PHYCOMYCETES.

ORDER PERONOSPORALES.

Albugo candida (Pers.) Kuntze, on *Brassica arvensis*,

Albugo candida (Pers.) Kuntze, on *Bursa bursa-pastoris*, Kulm.

Basidiophora kellermanni (E. & H.) Wilson, on *Iva xanthifolia*, Kulm.

CLASS ASCOMYCETES.

ORDER HELVELLALES.

Morchella conica, edible.

ORDER PEZIZALES.

Lachnea setosa (Nees.) Sacc.

Phaeopeziza fuscocarpa (Ell. & Holw.) Sacc.

Mollissia dehnii Karst., on *Potentilla monspeliensis.*

Rhytisma salicinum (Pers.) Fries on *Salix longifolia*, Red Lake, Logan County.

ORDER HYSTERALES.

Hypoderma scirpinum, on *Scirpus lacustris.*

ORDER PERISPORIALES.

Erysiphe polygonum D. C. on *Polygonum aviculare*, Kulm.

Microsphaeria alni (Wall.) Wint., on *Syringa vulgaris*, Kulm.

ORDER HYPOCREALES.

Hypocrea richardsonii (B. & M.), on *Populus tremuloides*, Fargo.

Claviceps nigriceps Tul., on *Eleocharis palustris*, Kulm.

Claviceps purpurea (Fr.) Tul., on *Calamagrotis neglecta*, Kulm.

ORDER DOTHIDEALES.

Phyllachora graminis (Pers.) Fuck., on *Sporobolus asperifolius*, Kulm.

Phyllachora graminis (Pers.) Fuck., on *Sporobolus cuspidatus*, Kulm.

Phyllachora tracyi E. & E., on *Distichlis spicata*, Kulm.

ORDER SPHAERIALES.

Ophiobolus anguillides (Cooke) Sacc., on dead *Iva xanthifolia*, Kulm.

Physalospora aurantii Ell. & Ev., on *Astragalus adsurgans*, Kulm.

Valsa salicina (Pers.) Fr., on branches of *Golden Willow*, Kulm and Fargo.

CLASS BASIDIOMYCETES.

ORDER USTILAGINALES.

FAMILY USTILAGINACEAE.

Ustilago avenae (Pers.) Jens. on *Avena sativa*, Kulm.

Ustilago hordei (Pers.) Kell. & Sw., on *Hordeum vulgare*, Kulm.

Ustilago lorentziana Thuem., on *Hordeum jubatum*, Kulm.

Ustilago nuda (Jens) Kell. & Sw., on *Hordeum vulgare*, Kulm.

Ustilago maydis (D. C.) Corda, on *Zea mays*, Kulm.

FAMILY TILLETINACEAE.

Urocystis anemonis (Pk.) Schroet, on *Pulsatilla hirsutissima*, Kulm.

ORDER UREDINALES.

Melampsora salicis-caprae (Pers.) Wint., on *Salix longifolia*, Kulm.

FAMILY PUCCINIACEAE.

Uromyces eleocharidis Arth., on *Eleocharis olivacea*, Kulm.

Uromyces eleocharidis Arth., on *Eleocharis palustris*, Kulm.

Uromyces glycyrrhizae (Rabenh.) Magn., on *Glycyrrhiza lepidota*, Kulm.

Uromyces junci (Desm.) Tul., on *Juncus balticus*, Kulm.

Uromyces silphii (Syd.) Arth. III, on *Juncus tenuis*, Kulm.

Puccinia amphibii Fuckel, on *Polygonum sp.*, Kulm.

Puccinia andropogonis Schw. II & III, on *Andropogon furcatus*, Kulm.

Puccinia caricis (Schum.) Reb. III, on *Carex aristata*, Kulm.

Puccinia caricis (Schum.) Reb., on *Carex utriculata*, Kulm.

Puccinia ellisiana Thuem. II & III, on *Andropogn scoparius*, Kulm.

Puccinia fraxinata (Link.) Arthur, on *Spartina cynosuroides*, Kulm.

Puccinia graminis Pers., on *Agropyrum glaucum*, Kulm.

Puccinia graminis Pers., on *Hordeum jubatum*, Kulm.

Puccinia helianthi Schw. III, on *Helianthus maximilianus*, Kulm.

Puccinia menthae II & III, on *Mentha canadensis*, Kulm.

Puccinia polygoni-amphibii, Pers. II & III, on *Polygonum emersum*, Kulm.

Puccinia rubefaciens Johans. III, on *Galium boreale*, Kulm.

Puccinia silphii Schw., on *Silphium perfoliatum*, Fargo.

Puccinia subnitens Dietl. II & III, on *Distichlis spicata*, Kulm.

Puccinia vexans Farl. II, III & X, on *Bouteloua curtipendula*, Kulm.

Phragmidium americanum (Pk.) Dietl., on *Rosa arkansana*, Kulm.

Phragmidium potentillae Wint. II & III, on *Potentilla strigosa*, Kulm.

Phragmidium subcorticium W. I, II & III, on *Rosa blanda*, Kulm.

CLASS BASIDIOMYCETES.

ORDER HYMENIALES.

FAMILY POLYPORACEAE.

Poronidulus conchifer (Schw.) Murr., on dead *Ulmus*, Fargo.

Cerrena unicolor (Bull.) Murril, Fargo.

Lenzites betulina Fr., on stump of box-elder, Fargo.

Schizophyllum commune Fr., a wound fungus on young apple trees, Fargo.

Polyporus arcularius, (Batsch.) Fries, Fargo.

Pleurotus ostreatus, a wound fugus on box-elder (edible mushroom), Fargo.

Armillaria mellea (Edible mushroom), Fargo.

Marasmius rotula Fr., Fargo.

Agaricus campestris (Edible mushroom), A. C. campus. Fargo.

Collybia velutipes Curt., Fargo.

ORDER LYCOPERDALES.

Catastoma circumscissum B. & C., Kulm.

Geaster asper Michel, on old manure, Kulm.

Geaster floriformis Vittad., on open prairie, Kulm.

LICHENS.

Lecanora hageni Och. var., on limestone, Kulm.

Lecanora muralis (Schreb.) var. *Saxicola* Schaer, Kulm.

Lecidea contigua Fr., Kulm.

Placodium elegans (Link.) D. C., Kulm.

Placodium vittelinum (Erhrh.) N. & H., Kulm.

Physcia obscura (Erhrh.) Nyl, Kulm.

Physcia stellaris var. *aipolia* Nyl, Kulm.

Urceolaria scruposa, (L.) Nyl. *parasitica* Sommerfelt, Kulm.

Agricultural College, Dec. , 1909.

H. F. Bergman."

Work Done Under the Seed Control Act (Pure Seed Law): The law went into eceet July 1st, 1909, at a time when the purchase, sale and distribution of seed was not largely in operation. The months of July, August and September were occupied in fitting out the Laboratory, procuring of apparatus, etc., necessary for its operation, and the publishing and distribution of literature to call the attention of parties most concerned to the work that might be expected to be undertaken. Mr. O. A. Stevens, a graduate of the Agricultural College of Kansas, was hired to take charge of the work of the laboratory and commenced active work September 1st. The work under the law naturally contemplates furnishing a laboratory in which any citizen of the state can learn regarding the quality of seeds which he might have in his possession for sale, or be considering with a view to purchase, and a place in which investigations can be carried on which will eventually allow those in charge to furnish information of a character most liable to improve the quality of seed that is offered for sale in the state. In carrying out this work the efforts of the officers naturally fall under three divisions: (1) Examination of seed samples submitted by those who are considering them with a view to purchase. (2) Examination of seeds submitted by farmers of their own growing. (3) Field inspection with a view of ascertaining by inspection whether seeds on the market are being sold with due regard to the quality and purity as specified in the law. In this work it will of course be impossible to inspect anything like all of the seeds which are placed upon the market for sale, but all samples so collected will be examined and recorded. In case of evident carelessness or intention to defraud proper remedial steps will be taken according to the law.

Samples are examined in the laboratory both for purity and for viability. The person sending the sample, or from whom it is taken by inspectors, will be informed of the result of the examination. The report shows definitely the name of each kind of weed seed and the number of seeds found in a weighed amount of the sample. It also shows the total percentage of foreign seeds by weight, the total percentage of trash and the total percentage of pure seed, and finally the percent of growths which the pure seed will make under standard tests. Such a report, therefore, allows the person receiving the same to readily decide whether or not the sample is of such nature as he wishes to buy. In the case of several samples of the same kind of seed submitted at the same time it is easy to decide from the reports which

sample contains the most valuable seed and the greatest amount of injurious seeds.

The seeds so far collected have been freely submitted by the various seed houses with a view to purchase or with a view of ascertaining the character of their stock now on hand. This being the case no publication of names will be made upon the samples so obtained. The field inspection work will take place at a time when the seeds are being most freely sold and distributed and we will thus be able to ascertain whether our local seedsmen have purchased the good samples and failed to handle the poor ones which were offered them.

I herewith append the statement of the work of the Laboratory as outlined by Mr. O. A. Stevens, including the samples received between the dates of July 1st, 1909 and Jan. 1, 1910. Laboratory records 1 to 716, inclusive:

Equipment and Methods of Work: The work of the seed laboratory may be classed under two divisions, viz: (1) Investigation to determine new methods or to improve old ones, and (2) Testing of commercial seeds. During these first few months of the existence of the laboratory, a considerable amount of time has necessarily been expended in installing the various fixtures and testing certain methods. The following paragraphs outline briefly the methods of work which have been carried on.

Tests of Purity: To determine the percentage of pure seed, the sample in question is mixed as thoroughly as possible and a small amount—varying according to the kind of the seed, 1 gram, about 1-30 ounce, for Red Top, 2 grams for Timothy, 5 grams for Red Clover, etc.,—is weighed out, and carefully separated by hand into three lots: (1) Pure seed, (2) foreign seed, (3) trash. The percentage by weight of each of these is recorded, also the name and number of each kind of foreign seed.

If a large number of any kind of foreign seed is present the percentage by weight is determined, also by count in the following manner: Five hundred or a thousand seeds of the lot of pure seed are counted out and weighed. From this the number in the amount examined is computed. Then by dividing the number of foreign seed found in the amount examined by the number of seed true to name, we have the percentage by count, or more properly speaking, the number per one hundred of pure seed. The remainder of the sample is also examined and the presence of foreign seeds not already found is noted. Such a test is often tedious and con-

sumes much time. It appears, however, to be the only exact and, in general, the most satisfactory method. Chaffy samples of fine grass seeds require the greatest amount of work. We have recently constructed a very simple piece of apparatus which promises to facilitate such work by removing the fine chaff by means of an air blast. This is done in a long glass tube and the chaff is carefully collected for weighing and for examination, if necessary.

In case of some grasses, especially the blue grasses, it is difficult to tell whether the pair of scales which usually remains closely attached to the seed, actually enclose a seed, or are empty. For determining this we are at present trying this method. The seeds are placed on a glass and subjected to light from below only, so that a seed appears as a dark body between the somewhat transparent scales.

To determine the names of the foreign seeds a thorough knowledge of the distinguishing characters is necessary. It is sometimes the case that seeds of plants of entirely different natures and values are so alike in appearance, that they can be separated only by the most careful study. The study of the distinguishing marks of such seeds is a most important field for the seed laboratory. Some such work has been done, and we feel that we have already made considerable progress.

Tests of Germination: For testing the growing power of seeds the laboratory is provided with a Standard germinating chamber and two refrigerator boxes. One of the latter we are at present using with a group of electric bulbs for a heating arrangement. The former is heated by gas and so regulated that any desired temperature may be maintained.

For a large part of the work we use a shallow pan partly filled with sand covered by a filter paper on which the seeds are placed. Enough water is kept in the sand so that the paper remains moist and a cover is used to prevent drying out. These pans are placed in a steam sterilizer for an hour each time before starting a new test, and the filter paper is changed for each test and the pans and sand sterilized for each test. This destroys the fungi of the preceding lot of seeds and any mold growth must come from the seeds then in the pan. Such tests at ordinary room temperature seem to be quite satisfactory for most seeds.

The interior of the Standard chamber is kept moist by the evaporation of water from a pan in the base. Large seeds such as squash are placed between folds of canton

flannel; medium sized seeds, as clovers and the larger grasses, between folds of blotting paper; small sized, as Timothy, Red Top, etc., on top of blotters. The cloth or blotters are first soaked in water and are laid upon trays of brass wire. The temperature used for most seeds is an alternating one of about 80° Fahr. for one-third or one-fourth of each twenty-four hours and about 60° Fahr. for the remainder. These conditions seem to give better results with some seeds, especially the small grass seeds.

Sand tests in the greenhouse are used for check tests; also for some seeds with thick coverings liable to mold, such as beet, four-o-clock and nasturtiums, for which sandy soil seems to give best results. The sand is boiled frequently to destroy growths of mold.

Two or more tests are made in all doubtful cases, and the results of only those in which the conditions seem quite satisfactory are used.

The blue grasses are about the most difficult from which to secure satisfactory results. At present we are trying the Copenhagen or Jacobsen apparatus, which is much used for these seeds. The seeds are placed on a blotter which lies on a cloth kept moist by a wick extending into a dish of water; a glass cup placed over them prevents drying out, while a small opening in it provides air. The best results thus far obtained have been secured in the greenhouse, both with this apparatus and in sand.

With clovers and other legumes some seeds usually remain "hard" at the close of the test ;i. e. they do not absorb water or undergo any change. When left under suitable conditions they often germinate after long periods of time and it is the usual custom to consider one-third of them as germinating. In the following tables this has not been done but they have been reported separately. Experiments are being continued with a view of finding, if possible, a way to cause them to germinate in the usual length of time. The number of such "hard" seeds has in a few cases been as high as half the entire amount. The average of each kind appears in the tables.

Samples Received: The samples received and tested during this period have in most part been sent by dealers to whom they were offered by other parties. The total number received was 720 which may be classified as follows:

1.	Miscellaneous for identification	10
2.	Field seeds for purity or germination tests	302
3.	Garden seeds for germination tests	131
4.	Flower seeds for germination tests	277
	Total	720

Seeds Sent for Identification:

Hog Peanut (*Falcata Pitcheri*)	1
Oats	1
White Cockle (*Lychnis alba*)	1
Vetch (*Vicia cracca*)	1
Common Wheat	4
Durum, varieties	2

Field Seeds: The greater number of the samples were sent for purity tests, but germination tests were also made in most cases. The number of samples of each received was:

Alfalfa	30
Alfalfa gradings	4
Blue grass, Canada	3
Blue grass, Kentucky	27
Barley	2
Brome grass	9
Buckwheat	2
Clover, Alsike	17
Clover, Red	60
Clover, White	16
Corn, field	21
Corn, fodder sweet	1
Fescue, meadow	1
Fescue, sheep	4
Flax	1
Lawn Grass	3
Millet, Broom-corn	3
Millet, common	18
Oats	3
Orchard Grass	2
Peas, field	3
Rape	4
Red Top	18
Rye	2
Timothy	37
Timothy and Alsike Clover	4
Wheat	2
Wheat-grass, Western	1
Total	302

Percentages of Purity and Germination: The following table presents some of the details of the samples of field seeds tested. Where a number of samples of one kind have been tested, only the records for a few of the best and of the poorest samples and the average of all tests are given:

TABLE I.

RESULTS OF TESTS OF PURITY AND GERMINATION.

Name of Seed	Record No. of Sample	% of Pure Seed	% of Foreign Seed	% of Trash	% of Pure Seed Which Germinated	% "Hard" Seed	Bad Types of Weed Seeds
Alfalfa	438	99.4	Trace	.6	91	4	None.
	434	99.9	Trace	.1	83	17	None.
	433	99.7	Trace	.3	74	20	Sorrel Dock.
	83	94.4	2.4	3.2	81	15	Dodder, 6.4% by count, Russian Thistle.
	355	97.7	1.1	1.2	45	55	Dodder, 1.3% by count,
	436	95.3	4.1	.6	83	5	Dodder, Sweet Clover, Russian Thistle.
Average of all samples tested		98.37	.60	1.03	75.13	20.43	
Clover, Alsike	470	98.8	.5	.7	79	22	Sorrel Dock.
	378	95.5	1.2	3.3	79	20	None.
	88	92.3	5.2	2.5	69	29	Sorrel Dock, 5.4% by count, Plantain, Catchfly.
	367	92.1	6.5	1.4	80	15	Sorrel Dock, 4.1% by count.
Average of all samples tested		92.43	6.0	1.57	78.25	16.44	
Clover, Red	87	98.1	1.6	.3	85	15	None.
	95	98.3	.4	1.3	72	27	None.
	185	88.4	7.8	3.8	63	25	Lamb's-quarters, 3.6% by count.

TABLE I (Continued)

RESULTS OF TESTS OF PURITY AND GERMINATION

Name of Seed	Record No. of Sample	% of Pure Seed	% of Foreign Seed	% of Trash	% of Pure Seed Which Germinated	% "Hard" Seed	Bad Types of Weed Seeds
Red Clover	185						Pigeon-grass, 16.4% by count. Pepper-grass, 2.6% by count. Crab-grass, 2.3% by c't. Plantain, .8% by count. Catchfly.
	372	92.2	6.5	1.3	82	17	Pigeon-grass, 5.0% by count. White Cockle, 4.6% by count. Lamb's-quarters, 2.7% by count. Sorrel Dock, .6% by c't.
	400	99.4	.1	.5	80	13	Lamb's-quarters.
	412	77.5	19.8	2.7	75	14	Pigeon-grass, 19.7% by count. Primrose, 12.6% by c't. Lamb's-quarters, 7% by count. Catchfly.
	560	99.2	.4	.4	90	8	None.
	615	98.6	.8	.6	87	8	Pigeon-grass.
	628	99.8	Trace	.2	95	4	Sorrel.
Average of all samples tested		96.0	2.74	1.26	78.95	14.62	

TABLE I (Continued)

RESULTS OF TESTS OF PURITY AND GERMINATION

Name of Seed	Record No. of Sample	% of Pure Seed	% of Foreign Seed	% of Trash	% of Pure Seed Which Germinated	% "Hard" Seed	Bad Types of Weed Seeds
Clover, white	Average of all samples tested	96.15	3.31	.54	75.13	14.80	
Ky. Blue Grass	30	95.9	.8	3.3	52		Sorrel Dock.
	360	95.4	.2	4.4	73		Sorrel Dock.
	375	92.5	1.0	6.5	68		Sorrel Dock.
	339	91.8	.2	8.0	27		None.
	468	49.3	1.2	49.5	15		Narrow-leaved Plantain, Dock, Sedge.
Average of all samples tested		82.79	.64	16.57	43.88		
Red Top	374	95.0	1.0	4.0	93		Ergot, Yarrow.
	413	8.0	2.6	89.4	50		Ergot, Yarrow.
	340	83.0	9.0	8.0	20		Ergot, Yarrow, Timothy, 8% by weight.
Average of all samples tested		80.38	7.0	16.62	47.63		
Timothy	76	99.80	.1	.1	96		Pepper-grass.
	454	99.20	.3	.5	90		Pepper-grass, Broad Plantain.
	565	98.60	.3	1.1	93		None.
	653	99.80	Trace	.2	95		None.
	79	86.00	10.8	3.2	66		None.
							Potentilla, 2.8% by c't.

TABLE I (Continued)

RESULTS OF TESTS OF PURITY AND GERMINATION

Name of Seed	Record No. of Sample	% of Pure Seed	% of Foreign Seed	% of Trash	% of Pure Seed Which Germinated	% "Hard" Seed	Bad Types of Weed Seeds
Timothy	79						Pepper-grass, 4.3% by count. Quack-grass.
Average of all samples tested		98.73	1.00	.27	90.32		
Common Millet	Average of all samples tested	97.99	1.90	.11	86.83		
Brome Grass	Average of all samples tested	88.80	1.77	9.43	79.55		
Canada Blue Grass	2				0		
	13				16		
	19						
Buckwheat	21	100	0	Not determined			
	586			100			
Corn Average of all samples tested					87.52	5 below 80% 13 above 90%	
Meadow Fescue	80	93.9	1.6	4.5	62		Wild Oats, Mustard.
Sheep Fescue	14				55		
	15				48		
	440	99.3	.7		70		
	441	88.3	2.7		63		
Flax					86		

TABLE I (Continued)

RESULTS OF TESTS OF PURITY AND GERMINATION

Name of Seed	Record No. of Sample	% of Pure Seed	% of Foreign Seed	% of Trash	% of Pure Seed Which Germinated	% "Hard" Seed	Bad Types of Weed Seeds
Oats	Average of all samples tested	98.92	.70		93.66		Wild Oats in one sample
Orchard Grass	27	95.5	1.0		41		
	31				43		
Field Peas	588				100		
	462				95		
	525				74		
Rape	Average of all samples tested				90		
Rye	9						
	32	97.95	.15		95		Wild Oats.
Timothy & Alsike Clover	402	99.0 (T. 49.5) (Al. 49.6)	.4	.5	(T.-81) (Al.-75)		
	409	87.8 (T. 74.6) (Al. 13.2)	6.0	6.2	(T.-94) (Al.-56)		
	426	99.5 (T. 90.1) (Al. 9.4)	Trace	.5	(T.-91) (Al.-62)		
	647	91.4 (T. 72.9) (Al. 18.5)	5.4		(T.-73) (Al.-56)		
Wheat	10				97		
	35				97		
Wheat-grass	495	99.4	0		88		

Foreign Seeds Found in Various Samples of Field Seeds: The following statements show about the range of weed seeds that were found in the various kinds of field seeds. These statements contain only the names of the plants that are usually considered to be weeds, and do not contain the foreign seeds that are usually considered as valuable plants.

Alfalfa—Thirty Samples Examined: In one instance the Dodder amounted to 2.3% by weight, or 6.4% by count; in a second, 1.3% by count. Russian Thistle in one case 1.1% by count.

The principal weed seeds and the number of samples in which they were found, were as follows:

Mustard (*Brassica sp.*)	6
Black Mustard (*B. nigra*)	1
Charlock (*B. arvensis*)	1
Lamb's-quarters (*Chenopolium album*)	15
Green Pigeon-grass (*Chaetochloa viridis*)	10
Chicory (*Cichorium intybus*)	3
Dodder, field (*Cuscuta arvensis*)	2
Dodder, clover, (*C. epithymum*)	1
Dodder, small seeded alfalfa (*C. planiflora*)	1
Sweet Clover (*Melilotus alba*)	10
Sweet Clover (*M. indica*)	1
Narrow-leaved Plantain (*Plantago lanceolata*)	5
Dock (*Rumex sp.*)	4
Sorrel Dock (*R. acetosella*)	2
Russian Thistle (*Salsola tragus*)	7
Pigweed (*Amaranthus retroflexus*)	3
Tumbleweed (*A. graecizans*)	1
Ragweed (*Ambrosia artemisiaefolia*)	1
Salt-bush (*Atriplex sp.*)	3
Cheat (*Bromus secalinus*)	1
Thistle, Prairie (*Carduus altissimus*)	4
Goosefoot (*Chenopodium sp.*)	7
Yellow Foxtail (*Chaetochloa glauca*)	1
Hare's-ear Mustard (*Conringia orientalis*)	2
Barnyard-grass (*Echinochloa crusgalli*)	2
Roquette (*Eruca sativa*)	3
Gum-weed (*Grindelia squarrosa*)	2
Sunflower (*Helianthus sp.*)	3
Red-river Weed (*Iva xanthiifolia*)	5
Pepper-grass (*Lepidium sp.*)	2
Stickseed (*Lappula lappula*)	1
Stickseed (*L. texana*)	1

Cheeses (*Malva rotundifolia*) 2
Witch-grass (*Panicum capillare*) 2
Wild Buckwheat (*Polygonum convolvulus*) 2
Smartweed (*Polygonum persicaria*) 2

Canada Blue-grass: 3 samples, the following found:
Canada Thistle (*Carduus arvensis*) 1
Pepper-grass (*Lepidium sp.*) 2
Potentella (*Potentilla monspeliensis*) 2
Sorrel Dock (*Rumex acetosella*) 1

Kentucky Blue-grass: 24 samples, the following found:
Shepherd's Purse (*Bursa bursa-pastoris*) 11
Mouse-ear Chickweed (*Cerastium vulgatum*) 17
Narrow-leaved Plantain (*Plantago lanceolata*) 1
Sorrel Dock (*Rumex acetosella*) 18
Dock (*Rumex sp.*) 7
Catchfly (*Silene antirrhina*) 6
Dandelion (*Taraxacum taraxacum*) 2
False Flax (*Camelina sativa*) 1
"Ergot" (*Claviceps sp.*) 1
Pepper-grass (*Lepidium sp.*) 3
Potentilla (*Potentilla monspeliensis*) 1

Brome Grass: 9 samples, the following found:
Quack-grass (*Agropyron repens*) 1
Cheat (*Bromus secalinus*) 1
Thistle (*Carduus altissimus*) 1
Green Pigeon-grass (*Chaetochloa viridis*) 1
Lamb's-quarters (*Chenopodium album*) 1
Wild Buckwheat (*Polygonum convolvulus*) 2
Russian Thistle (*Salsola tragus*) 2

Alsike Clover: 16 samples, the following found:

The amount of Sorrel Dock was often large, being in four cases 5.4, 1.7, 1.3 and 4.1% by count. One sample had 1.7% by count and another 2.1% by weight of Catchfly. The percentages of foreign seed was often high, on account of Timothy and Red Clover, one sample containing 9% by weight of Timothy, and 6.7% of Red Clover; another 16.1% by weight of Timothy.

Quack-grass (*Agropyron repens*) 1
Green Pigeon-grass (*Chaetochloa viridis*) 6
Lamb's-quarters (*Chenopodium album*) 7
Sorrel Dock (*Rumex acetosella*) 11
(*Rumex sp.*) 6
Catchfly (*Silene noctiflora*) 8

Pigweed (*Amaranthus retroflexus*) 1
Yellow Trefoil (*Medicago lupulina*) 1
Pepper-grass (*Lepidium sp.*) 3
Evening Primrose (*Onagra biennis*) 2
Plantain (*Plantago rugelii*) 1
Smartweed (*Polygonum persicaria*) 1
Potentilla (*Potentilla monspeliensis*) 5

Red Clover: 60 samples examined, the following found:

Green Pigeon-grass was usually present in greatest amount. In 17 samples containing most, there was an average of 4.8% by weight and 7.1% by count. In six cases there was respectively 3.6, 2.7, 7.7, 1.5, 1.6 and 7.0% by count of Lamb's-quarters. One sample had by count 2.6% of Pepper-grass and 2.3% of Crab-grass. One had by count .6% Sorrel Dock and 4.6% White Cockle. Another had 12.6% by count Evening Primrose. Another had .5% by weight Sorrel Dock.

Bull Thistle (*Carduus lanceolatus*) 1
Green Pigeon-grass (*Chaetochloa viridis*) 45
Yellow Pigeon-grass (*Chaetochloa glauca*) 15
Lamb's-quarters (*Chenopodium album*) 35
Wild Carrot (*Daucus carota*) 3
White Cockle (*Lychnis alba*) 3
Pepper-grass (*Lepidium sp.*) 14
Evening Primrose (*Onagra biennis*) 6
Witch-grass (*Panicum capillare*) 15
Narrow-leaved Plantain (*Plantago lanceolata*) 8
Smart Weed (*Polygonum persicaria*) 17
Catchfly (*Silene noctiflora*) 13
Small Crab-grass (*Syntherisma linearis*) 11
Common Crab-grass (*Syntherisma sanguinalis*) 1
Sorrel Dock (*Rumex acetosella*) 24
Dock (*Rumex sp.*) 13
Three-seeded Mercury (*Acalypha virginica*) 1
Pigweed (*Amaranthus retroflexus*) 4
Pigweed (*Amaranthus sp.*) 1
Ragweed (*Ambrosia artemisiaefolia*) 8
Weather-glass (*Anagallis arvensis*) 1
Mustard (*Brassica sp.*) 1
Thistle (*Carduus undulatus*) 1
Hare's Ear Mustard (*Conringia orientalis*) 1
Barnyard-grass (*Echinochloa crusgalli*) 12
Spurge (*Euphorbia sp.*) 5
Geranium (*Geranium carolinianum*) 2
Wild Barley (*Hordeum jubatum*) 1

Water Hoarhound (*Lycopus americanus*)	2
Cheeses (*Malva rotundifolia*)	1
Yellow Trefoil (*Medicago lupulina*)	1
Horse Mint (*Monarda sp.*)	1
Wood Sorrel (*Oxalis sp.*)	1
Spreading Panicum (*Panicum proliferum*)	1
Ground Cherry (*Physalis sp.*)	1
Common Plantain (*Plantago major*)	4
Rugel's Plantain (*Plantago rugelii*)	8
Knotweed (*Polygonum aviculare*)	4
Wild Buckwheat (*Polygonum convolvulus*)	3
Smartweed (*Polygonum lapathifolium*)	1
Smartweed (*Polygonum pennsylvanicum*)	1
Knotweed (*Polygonum sp.*)	2
Potentilla (*Potentilla monspeliensis*)	6
Self-heal (*Prunella vulgaris*)	1
Catchfly (*Silene sp.*)	1
Rush-grass (*Sporobolus neglectus*)	1
Rush-grass (*Sporobolus vaginaeflorus*)	1
Rush-grass (*Sporobolus sp.*)	1
Vervain (*Verbena bracteosa*)	1
Vervain (*Verbena hastata*)	1
Vervain (*Verbena sp.*)	2

White Clover: 13 samples examined, the following found: Principal weed seeds were the various species of Plantain and Sorrel. The latter was present in two cases to the extent of .7 per cent and .4 per cent by count. Catchfly was found in one instance to the amount of 2.6 per cent by weight.

White Cockle (*Lychnis alba*)	1
Common Plantain (*Plantago major*)	6
Pepper-grass (*Lepidium sp.*)	4
Rugel's Plantain (*Plantago rugelii*)	3
Narrow-leaved Plantain (*Plantago lanceolata*)	4
Sorrel Dock (*Rumex acetosella*)	10
Catchfly (*Silene noctiflora*)	3
Chickweed (*Alsine media*)	3
Dog-fennel (*Anthemis cotula*)	1
Camomile (*Anthemis tinctoria*)	1
Shepherd's Purse (*Bursa Bursa-pastoris*)	1
Mouse-ear Chickweed (*Cerastium vulgatum*)	1
Lamb's-quarters (*Chenopodium album*)	4
Yellow Trefoil (*Medicago lupulina*)	2
Catnip (*Nepeta cataria*)	1
Evening Primrose (*Onagra biennis*)	1

Wood Sorrel (*Oxalis sp.*)	1
Witch-grass (*Panicum capillare*)	1
Potentilla (*Potentilla monspeliensis*)	4
Self-heal (*Prunella vulgaris*)	2
Black-eyed Susan (*Rudbeckia hirta*)	1
Hedge Mustard (*Sisymbrium officinale*)	1
Vervain (*Verbena hastata*)	1

Meadow Fescue: 1 sample, the following found:
Wild Oats (*Avena fatua*).
Charlock (*Brassica arvensis*).
False Flax (*Camelina sativa*).
Green Pigeon-grass (*Chaetochloa viridis*).
Hare's-ear Mustard (*Conringia orientalis*).
Stick Seed (*Lappula lappula*).
Pepper-grass (*Lepidium sp.*)
Ball Mustard (*Neslia paniculata*).
Hedge-nettle (*Stachys sp.*)
French-weed (*Thlaspi arvense*).

Sheep Fescue: 4 samples, the following found:

Cheat (*Bromus secalinus*)	2
Yellow Trefoil (*Medicago lupulina*)	1
Narrow-leaved Plantain (*Plantago lanceolata*)	1
Sorrel Dock (*Rumex acetosella*)	2

Lawn Grass: 3 samples, the following found:

Milfoil (*Achillea millefolium*)	2
Chickweed (*Alsine media*)	1
Pigweed (*Amaranthus retroflexus*)	1
Dog-fennel (*Anthemis cotula*)	1
Cheat (*Bromus secalinus*)	1
Shepherd's Purse (*Bursa Bursa-pastoris*)	1
Canada Thistle (*Carduus arvensis*)	1
Corn-flower (*Centaurea cyanus*)	1
Mouse-ear Chickweed (*Cerastium vulgatum*)	3
"Ergot" (*Claviceps sp.*)	3
Cats-ear (*Hypocheris sp.*)	1
Pepper-grass (*Lepidium sp.*)	1
Potentilla (*Potentilla monspeliensis*)	3
Potentilla (*Potentilla sp.*)	1
Bracted Plantain (*Plantago aristata*)	1
Rugel's Plantain (*Plantago rugelii*)	2
Black-eyed Susan (*Rudbeckia hirta*)	1
Sorrel Dock (*Rumex acetosella*)	3
Buttercup (*Ranunculus sp.*)	3
Annual Sow-thistle (*Sonchus asper*)	1

Millet, Broom-corn: 3 samples, the following found:

Wild Oats (*Avena fatua*)	1
Charlock (*Brassica arvensis*)	1
Yellow Pigeon-grass (*Chaetochloa glauca*)	2
Green Pigeon-grass (*Chaetochloa viridis*)	1
Lamb's-quarters (*Chenopodium album*)	1
Wild Buckwheat (*Polygonum convolvulus*)	3
Pink Cockle (*Vaccaria vaccaria*)	2

Millet, Common: 13 samples, the following found:

Amaranth (*Amaranthus blitoides*)	1
Pigweed (*Amaranthus retroflexus*)	1
Ragweed (*Ambrosia artemisiaefolia*)	1
Charlock (*Brassica arvensis*)	1
Yellow Pigeon-grass (*Chaetochloa glauca*)	8
Green Pigeon-grass (*Chaetochloa viridis*)	11
Lamb's-quarters (*Chenopodium album*)	7
Barnyard-grass (*Echinochloa crusgalli*)	3
Witch-grass (*Panicum capillare*)	2
Spreading Panicum (*Panicum proliferum*)	1
Smartweed (*Polygonum lapathifolium*)	1
Smartweed (*Polygonum pennsylvanicum*)	1
Narrow-leaved Plantain (*Plantago lanceolata*)	1
Wild Buckwheat (*Polygonum convolvulus*)	2
Smartweed (*Polygonum persicaria*)	7
Knotweed (*Polygonum sp.*)	1
Dock (*Rumex sp.*)	1
Russian Thistle (*Salsola tragus*)	1
Wild Sage (*Salvia lanceolata*)	1
Sida (*Sida spinosa*)	1
Common Crab-grass (*Syntherisma sanguinalis*)	6
Smaller Crab-grass (*Syntherisma linearis*)	6

Oats: 7 samples, the following found:

Cockle (*Agrostemma githago*)	1
Wild Oats (*Avena fatua*)	4
Mustard (*Brassica sp.*)	2
False Flax (*Camelina sativa*)	1
Lamb's-quarters (*Chenopodium album*)	2
Gum-weed (*Grindelia squarrosa*)	1
Sunflower (*Helianthus sp.*)	2
Wild Buckwheat (*Polygonum convolvulus*)	4
Dock (*Rumex sp.*)	1
French-weed (*Thlaspi arvense*)	1
Pink Cockle (*Vaccaria vaccaria*)	2

Orchard Grass: 2 samples, the following found:

Cheat (*Bromus secalinus*)	2
Narrow-leaved Plantain (*Plantago lanceolata*)	1
Sorrel Dock (*Rumex acetosella*)	7
Dock (*Rumex sp.*)	2

Red Top: 10 samples, the following found:

The principal foreign seed is "ergot." Red Top seeds affected with this disease are included with the foreign seed. In one case this was 2.9% by weight. Most common weed seeds are Milfoil and Dog-fennel. Timothy is often present in more or less quantity; in five cases respectively: 3.3, 5.7, 8.0, 15.0 and 16.2% by weight. Weed seed in all found as follows:

Milfoil (*Achillea millefolium*)	8
Pigweed (*Amaranthus sp.*)	1
Shepherd's Purse (*Bursa Bursa-pastoris*)	1
Dog-fennel (*Anthemis cotula*)	3
Chickweed (*Alsine media*)	2
Mouse-ear Chickweed (*Cerastium vulgatum*)	2
Lamb's-quarters (*Chenopodium album*)	1
"Ergot" (*Claviceps sp.*)	8
Spurge	1
Evening Primrose (*Onagra biennis*)	1
Pepper-grass (*Lepidium sp.*)	1
Bracted Plantain (*Plantago aristata*)	1
Rugel's Plantain (*Plantago rugelii*)	5
Common Plantain (*Plantago major*)	1
Pursh's Plantain (*Plantago purshii*)	1
Potentilla (*Potentilla monspeliensis*)	5
Sorrel (*Rumex acetosella*)	3
Skull-cap (*Scutellaria lateriflora*)	1
Catchfly (*Silene antirrhina*)	1

Rye: 1 sample; the following found:

Kinghead (*Ambrosia trifida*).
Wild Oat (*Avena fatua*).
Wild Buckwheat (*Polygonum convolvulus*).

Timothy: 27 samples. In one case, Potentilla 2.8% by weight, and Pepper-grass 4.3% by weight.

Quack-grass (*Agropyron repens*)	1
Wild Oats (*Avena fatua*)	1
Lamb's-quarters (*Chenopodium album*)	21
Water-hemlock (*Cicuta maculata*)	1
Poison-hemlock (*Conium maculatum*)	1
Pepper-grass (*Lepidium sp.*)	22

Common Plantain (*Plantago major*)	10
Rugel's Plantain (*Plantago rugelii*)	12
Potentilla (*Potentilla monspeliensis*)	21
Sorrel Dock (*Rumex acetosella*)	7
Dock (*Rumex sp.*)	4
Catchfly (*Silene noctiflora*)	8
Mustard (*Brassica sp.*)	2
False Flax (*Camelina sativa*)	1
Pigeon-grass (*Chaetochloa viridis*)	12
Yellow Pigeon-grass (*Chaetochloa glauca*)	2
"Ergot" (*Claviceps sp.*)	2
Hare's-ear Mustard (*Coringia orientalis*)	2
Dragon's-head (*Dracocephalum parviflorum*)	1
Barnyard-grass (*Echinochloa crusgalli*)	1
Wild Barley (*Hordeum jubatum*)	6
Red River Weed (*Iva xanthiifolia*)	1
Water-Hoarhound (*Lycopus americanus*)	2
Stickseed (*Lappula lappula*)	1
Bugle-weed (*Lycopus sp.*)	1
Evening Primrose (*Onagra biennis*)	15
Witch-grass (*Panicum capillare*)	2
Canada Blue-grass (*Poa compressa*)	2
Knot-weed (*Polygonum aviculare*)	1
Smartweed (*Polygonum persicaria*)	1
Self-heal (*Prunella vulgaris*)	1
Rose, wild (*Rosa sp.*)	3
Black-eyed Susan (*Rudbeckia hirta*)	5
Catchfly (*Silene antirrhina*)	1
Germander (*Teucrium canadense*)	1
French-weed (*Thlaspi arvense*)	3
Verbena (*Verbena hastata*)	3
Vetch (*Vicia sp.*)	2

Timothy and Alsike Clover: 4 samples, the following found:

Green Fox-tail (*Chaetochloa viridis*)	1
Sedge (*Carex sp.*)	2
Lamb's-quarters (*Chenopodium album*)	2
Pepper-grass (*Lepidium sp.*)	3
Water Hoarhound (*Lycopus americanus*)	1
Evening Primrose (*Onagra biennis*)	1
Witch-grass (*Panicum capillare*)	1
Common Plantain (*Plantago major*)	1
Rugel's Plantain (*Plantago rugelii*)	1
Knotweed (*Polygonum aviculare*)	1
Potentilla (*Potentilla monspeliensis*)	3

Buttercup (*Ranunculus sp.*) 1
Dock (*Rumex sp.*) 1

Wheat: 2 samples; the following found:
Lamb's-quarters (*Chenopodium album*).
Sunflower (*Helianthus sp.*)
Wild Buckwheat (*Polygonum convolvulus*).
Russian Thistle (*Salsola tragus*).
Vetch (*Vicia cracca*).

The following table shows the results of tests of garden seeds. Many duplicate tests have been made, especially where the ordinary conditions seemed unsatisfactory; and in such cases the higher results have been accepted.

TABLE II.

RESULTS OF TESTS OF GARDEN SEEDS.

Name	No. of Samples Tested.	Percent Germinating. Highest.	Lowest.	Average.
Asparagus	1	88		
Beans	13	100	58	81
Beet	11	(Sp's 156) (Balls 69)	(Sp'ts 18) (Balls 11)	(Sp'ts 86) (Balls 44)
Cabbage	15	99	64	78
Carrot	11	87	34	66
Cauliflower	2	71	1	36
Celeriac	3	34	0	13
Celery	13	83	11	50
Citron	2	90	82	86
Corn, sweet	10	94	32	81
Cucumber	21	100	47	80
Dill	1	44	44	44
Kale	2	76	74	75
Leek	3	85	63	74
Lettuce	20	100	66	95
Mangel	3	(Sp's 180) (Balls 69)	(Sp's 128) (Balls 46)	(Sp's 149) (Balls 59)
Muskmelon	3	95	93	94
Onion	31	98	34	82
Parsnip	4	73	38	61
Parsley	3	72	38	50
Peas	14	100	44	91
Pepper	4	48	14	26
Pumpkin	6	97	84	91
Radish	24	100	42	88
Ruta-baga	3	100	87	96
Sage	2	44	23	33½
Salsify	2	93	90	91½
Spinach	6	71	46	59
Squash	13	100	23	82
Sunflower	2	92	83	87½
Tomato	12	92	60	76
Turnip	9	98	43	77
Thyme	3	61	32	51
Water-melon	6	92	80	87

Flower Seeds: The following table shows the results of tests of flower seeds. Two or more tests were made in nearly every case where the quantity of seed was large enough. The results of the highest tests are here recorded:

TABLE III.

RESULTS OF TESTS OF FLOWER SEEDS.

Name	No. of Samples Tested.	Percent Germinating. Highest.	Lowest.	Average.
Ageratum	2	26	12	19
Allyssum	2	31	0	15½
Aster	1	46		
Bachelor's Button	1	17		
Balsam	1	88		
Candytuft	2	18	1	19½
Canterbury Bells	1	11		
Carnation	1	44		
Chrysanthemum	1	5		
Coreopsis	1	22		
Cypress Vine	2	62	54	58
Dianthus	1	44		
Eschscholtzia	1	14		
Forget-me-not	2	58	9	33½
Four-O'Clock	2	74	34	54
Godetia	1	28		
Holly-hock	2	37	34	35½
Larkspur	2	2	0	1
Marigold	2	21	21	23
Mignonette	2	51	13	32
Morning-glory	2	38	12	25
Nasturtium	2	46	15	30½
Nasturtium Fall	1	45		
Pansy	4	69	4	40
Petunia	2	19	14	16½
Phlox	1	0	0	0
Pink	1	75		
Poppy	2	62	1	31½
Portulaca	3	76	2	50
Salpiglossis	1	8		
Snap-dragon	1	13		
Stock	2	33	21	27
Sweet Peas	9	99	74	88
Sweet William	1	78		
Verbena	2	8		
Zinnia	2	40	38	39

Hard Seeds in Legumes: In our 19th Annual Report I called attention to the fact that northwestern grown clovers and alfalfa contained large percentages of what in the seed laboratories is spoken of as "hard seeds," ones which

under ordinary conditions do not germinate. We have worked with these sufficiently to convince us that all such hard seeds can be made to germinate. We have not as yet determined upon a satisfactory method which would be practical in farm use, though our experiments indicate that it is possible. Seed experts differ in their judgment as to whether these "hard seeds" have any farm value. We have conducted a number of experiments during the past year that would not tend to strengthen the argument that they have, though I am not satisfied that the experiments are sufficiently conclusive to allow us to assert that they are valueless. It may be possible that under some soil conditions they would be serviceable the same year they are sown. It is a peculiarity of such seeds that they do not seem to absorb moisture. If the coats are scratched or treated in cer-

Figure 1.—Species of native dodder attacking one of the native wild vetches, maturing its seeds in August at Winnipeg Beach in Manitoba.

This dodder attacks all sorts of vegetation but specially shrubs and the larger herbs.

tain peculiar ways chemically, which would allow them to absorb moisture they germinate freely as do the other seeds of the sample. So far our experiments would lead us to believe that they will not, however, when planted germinate sufficiently quick to be of any advantage to the farmer. A farmer must sow enough clover seed or alfalfa seed to make a stand, and the seeds must germinate sufficiently strong to bring about a stand of clover or alfalfa before the weeds and grasses can get command of the seed bed. The hard seeds are probably so slow as to be of little worth in this respect. The following experiment was conducted in the Botanical Garden during the past season. The seed selected was a standard sample of clover seed which was grown near Hillsboro in 1908. Forty different germination tests of this lot of seed indicated an average of 78 strong growths, 20 hard, 2 dead per hundred. By treatment, through scratching and the use of certain chemicals we were able to conclude that all of the hard seeds could be made to grow. Ten plots of this seed were planted on an evenly prepared seed bed by the Centgener method. Three hundred and eighty-four seeds were planted in each plot. The planting was done in such manner that all seeds were put down to an equal depth and had essentially equally conditions.

The following table shows the results obtained in the field:

(All seeds were planted June 14.)

Plot	Treatment of the Seed	Number of Plants up July 22nd.	Pct. of Seeds Which Grew in the Field
1	Check. No treatment of seed.	222	57.8
2	Hot-water. 80 C. 4 minutes.	139	36.0
3	Hot-water. 80 C. 2 minutes.	196	51.0
4	Hot-water. 80 C. 1 minute.	237	61.7
5	Hot-water. 90 C. 1 minute.	141	36.7
6	.1% Caustic Potash, 1 hour.	221	57.2
7	.1% Caustic Potash, 80 C. 1 m.	236	61.0
8	.1% Caustic Potash, 80 C. 2 m.	181	47.1
9	.1% Caustic Potash, 70 C. 1 m.	119	30.9
10	.1% Caustic Potash, 70 C. 1 m.	229	59.0

It is interesting to note from this table, that neither the untreated seed or any one of the treated samples, most of which treatments were supposed to improve the growth of the hard seed, succeeded in producing as many plants in the field under specially prepared planting conditions as the

sample produced sprouts when in the germination tests. The highest percentage of field growths was 61.7 per cent, while the average of forty tests in the laboratory showed 77 per cent. It is evident that considerable field work needs to be done in this line.

This is certainly a question of much importance as I find that our northwestern seeds and those which are grown in the dryer regions tend to be of harder nature and thus less liable under ordinary conditions than seeds from more moist regions. It is further important for us to make careful studies upon the effect of breeding and selection upon this question, and also the possibility of procuring treatments which will make the hard seeds immediately available for germination.

In our reports from the Seed Laboratory, the report is so made that the person sending the seeds will learn how many seeds germinated at once and how many yet remain hard for a certain number of days, together with how many seeds are actually dead. It is thus easy to tell which of two samples is of the most apparent value for immediate use.

There are some facts which we have accumulated in the Laboratory that indicate that old seeds are less liable to contain hard seeds but other data are needed to confirm this fact.

Dodder: It has been the contention of many seedsmen that the working of our law which prohibits the sale of seeds containing seeds of Dodder is not a wise one for the following reasons: (1) Dodder is cosmopolitan and no Clover or Alfalfa seeds are liable to be free from it. (2) Dodder does not ripen seed in the northwest.

With regard to the first statement I can affirm that it will not hold true. We find numerous samples of Clover and Alfalfa in the northwest that do not contain any trace of Dodder. Indeed samples which come from farmers of the northwest are much less liable to have Dodder seed in them than not. It is only the large wholesale seed houses, however, who are making complaints on this proposition. These men should keep the lots of Clover and Alfalfa seed which they buy separate. If they mix them before cleaning they will hardly be able to sell any Alfalfa or Clover seed that does not contain traces of Dodder. Our local seedsmen should look to their supply early, buying directly from clean lands and avoid mixing different lots until they are sure that such lots do not contain any of the weeds of the prohibited classes.

Figure 2.—Photograph of some plants of alfalfa grown at Haynes, North Dakota, in the season of 1909, from seed which was purchased and planted in the season of 1908.

This is evidence that the common field dodder (**Cuscuta arvensis**) can mature seed in North Dakota and may be very destructive to alfalfa. Eight square feet of ground produced over a pound of clean dodder seed, but the alfalfa was not able to mature a seed.

With regard to the second contention, that Dodder does not mature in the northwest, I may say that Dodder grows as an annual from the seed and if it does not mature in the regions which produce Clover and Alfalfa seeds, how does the seed get into the Clover and Alfalfa seed that is on the market? This is a question that our friends, the wholesale seedsmen, who are more concerned with making special grades of seed to sell than they are with regard to keeping samples which are clean clean, have not been able to answer. The point of the matter is that Alfalfa and Clover Dodders will ripen in any region where the host plants can ripen their seeds normally.

I herewith submit photograph of Alfalfa Dodder which ripened its seeds in profusion at Haynes, North Dakota, in the year 1909. We have other records which show that it may ripen at any point in North Dakota south of the Manitoba line.

Publications of the Experiment Station: Since our last Annual Report this Department has published the following regular Bulletins, Press Bulletins and Circulars:

Regular Experiment Station Bulletin Number 87—"Seed Disinfection and Crop Production—Methods and Types of Machinery Needed," January, 1910.

Special Seed Bulletin Number 1—"The Seed Control Act." This bulletin contains the full text of the Pure Seed Law with general contents and rulings with regard to the sending and testing of samples at the Seed Laboratory, inspection, etc.

Pure Seed Circulars Numbers 1 and 2, giving information regarding the testing and examination of samples at the Seed Control Laboratory.

Press Bulletin Number 33—"Deterioration in Wheat Yields Due to Root Rots and Blight Producing Diseases."

The Department has also revised and reissued a number of the Press Bulletins, for which there has been a large demand, including:

Number 23—"Resistant Seed Flax and How to Get It."

Number 26—"Means of Eradicating Dandelions on Parks, Lawns, Roadsides and Meadows."

Number 27—"Use of Chemical Sprays in Destroying Mustard, Kinghead and other weeds in Cereal Grain Fields."

Respectfully submitted.

HENRY L. BOLLEY,
Botanist and State Seed Commissioner.
January 12, 1910.

HORTICULTURAL DEPARTMENT

Director J. H. Worst:

Sir.—The work of the Horticultural Department for the year 1909 was largely a continuation of the work outlined and inaugurated during previous years. The work done was chiefly along the following lines:

FORESTY.

The different tree plantations have been carried along as originally planned. Five acres of conifers were planted, the planting being done in part to replace those that failed to live the previous year. Unusual care has been exercised in the planting of young coniferous trees in the forestry plots but the difficulty in getting them established has been much greater than was anticipated. While the climatic conditions are not favorable to the starting of coniferous trees, still these are not unsurmountable and the difficulty in getting our plantations started may be largely due to the soil which is quite different in character than that in which conifers are found growing.

Among the deciduous trees the green and white ash, soft maple, hackberry, black walnut and white birch made the most satisfactory growth. The eastern white ash seems perfectly hardy and is making an average yearly growth of about two feet. The black walnut fruited for the first time at the Station. A large number of trees of this species were grown during the season from nuts collected on the farm of R. M. Protsfield two miles from the Station|

The growth of the four-year-old trees was from two to three feet. None of the trees have shown any ill effects from cold weather and the present indications are that in a sufficiently moist soil like that of the Red River Valley the walnut will be a valuable tree for general planting.

The white birch made the best showing of any of the better grade of trees. Some of the five-year-old trees brought from a nearby forest three years ago made the remarkable growth of five and one-half feet, while the average growth for the three hundred trees was nearly four feet. This rapidity of growth, coupled with their beauty, usefulness and extreme hardiness should lead to their being very generally planted.

The Catalpa has been discarded as wholly unsuited to this climate.

The Norway maple seems to be too tender for general planting. The insect enemies of the cottonwood and Norway and Carolina poplars are increasing so as to discourage the general planting of these trees.

FRUIT TREE PLANTING.

The hail storm of August 29th, 1908, killed all of the young fruit trees and these were replaced in the spring of 1909. Those planted comprised most of the standard varieties of apples and plums suitable for this climate as well as a number of newer sorts.

The rapid spread of the Exoascus or so-called "plum pocket" is a very serious menace to plum growing and will necessitate the selection of strains that can in a measure resist this disease. Our own seedlings are being carefully culled with this end in view.

Plantings were made of the newer sorts of strawberries and bush fruits.

VEGETABLES.

Cultural and variety tests and the continued improvement through selection of the earlier and better strains of corn, tomatoes, and melons constitute the principal part of the work done in the vegetable garden. A large number of seedling asparagus plants were started as a preliminary to selecting a rust resistant strain.

INJURIOUS INSECTS.

Damage from grasshoppers was reported from several points and considerable injury from Hessian fly was found in many places in the north central part of the state. These fields were visited during the month of August and the farmers made acquainted with the methods of combatting the pests. The nursery stock of the various nurseries located in the state was examined for dangerously injurious insects. These were in all cases found to be apparently free from injurious pests, but trees of the cottonwood and Carolina poplar in places outside of the nursery were found to be covered with an insect scale that was destroying the trees.

In order to prevent the spread of this and other dangerous pests a nursery inspection law along the lines of the bill introduced at the last session of the legislature should be enacted. North Dakota is now the only state in the union having no such law.

PUBLICATIONS.

The publications for the year consisted of three Press Bulletins upon the respective subjects of vegetable growing, fruit growing and tree planting.

Respectfully submitted,

C. B. WALDRON.

Agricultural College, N. D., Jan. 25, 1910.

VETERINARY DEPARTMENT

President J. H. Worst, Director, Agricultural College, N. D.

Sir: During the last year, this department has continued its investigation of infectious anaemia of the horse. The studies made dealt especially with the clinical phases of the disease.

Those studies showed conclusively, that:

1. An infected horse may die of the disease without any reduction of the red blood corpuscles.

2. That certain cases may run along for considerable periods without an elevation of the body temperature.

3. That such horses, although they fail to present any clinical evidence of the disease, still carry the infectious agent and that when small quantities of their blood be injected into normal horses, the disease is **promptly** reproduced.

Those studies also are leading us to believe that if we are to find a reliable method of prophylaxis, we must first of all discover a reliable method by which occult cases of the disease may be diagnosed.

Along with other projected details of the swamp fever investigation, this question of diagnosis shall receive careful consideration.

Some experiments relative to artificial immunity were also undertaken, but nothing very definite was brought out by the same.

During the coming year we hope to undertake the study of the manner in which the virus is eliminated from the body and how it is transferred from horse to horse.

Up to this time we were not able to undertake this important feature of the disease, as we were not able to properly isolate the animals in the experiment.

With the approaching completion of the new stable the department will be in position to attend to the questions mentioned.

During our work on this disease some valuable records have been obtained, which will be used in the preparation of a station bulletin on this subject, which we hope to issue during the latter part of 1910.

The department has recently occupied its new quarters erected through a legislative appropriation, while during the past year its staff has been increased with two assistant veterinarians and a laboratory aid, the latter replacing the customary scholarship assistant.

Respectfully submitted,

L. VAN ES,
Veterinarian.

STATEMENT.

United States Appropriation, 1908-1909.

RECEIPTS.	Hatch Fund	Adams F'd
To receipts from the Treasurer of the United States as per appropriations for fiscal year ended June 30, 1909, under acts of Congress approved March 2, 1887, (Hatch Fund) and March 16, 1906, (Adams Fund)	$15,000.00	$11,000.00
DISBURSEMENTS.		
By Salaries	8,421.47	7,608.81
Labor	2,920.99	1,118.64
Publications	916.26	
Postage and Stationery	219.38	
Freight and Express	65.07	56.35
Heat, Light and Water	28.36	
Chemical Supplies	15.65	241.17
Seeds, Plants and Sundry Supplies	766.11	317.49
Fertilizers		4.40
Feeding Stuffs	630.80	437.82
Library		
Tools, Implements and Machinery	375.43	
Furniture and Fixtures	185.83	52.75
Scientific Apparatus	192.33	695.67
Live Stock		460.80
Traveling Expenses	179.20	6.10
Contingent Expenses	15.00	
Building and Repairs	68.12	
Total	$15,000.00	$11,000.00